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LEGUMINOUS RUSTS FROM MEXICO.

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THE following thirty-seven species of Uredinales, represented by 128 numbered collections, are, with two exceptions, part of the rich fruits of three vacation trips into Mexico, made by Mr. E. W. D. HOLWAY in 1898, 1899, and 1903. Some of the material secured on these excursions has already been reported upon by Mr. HOLWAY in an article in this journal (**31**:326–338. 1901), which included descriptions of thirty-one new species; a still earlier trip, made in 1896, was also reported by Mr. HOLWAY in this journal (**24**:23–38. 1897), in which forty-five new species of Uredineae were described, the descriptions being drawn by Dr. P. DIETEL, and with two species of ascomycetous fungi, one being the type of a new genus. Much material remains to be studied, which will undoubtedly yield many more new species.

The amount of excellent material secured by Mr. HOLWAY within the limited periods at his command shows him to be a collector of unusual activity and acumen. His specimens are ample, and as a rule contain the various spore stages, or all that could reasonably be expected to occur at one season of the year. Another most commendable feature in making these collections is the care taken to secure the exact determination of the host whenever feasible. Not only are bits of the inflorescence and fruit included, but whenever the host is in any way unfamiliar, specimens suitable for the phanerogamic herbarium are taken illustrating the foliage, flowers, and fruit of the plants as well as possible. These are given the same numbers as used for the fungi found on them. They are subsequently sent to specialists for determination, by which means accuracy of naming

is insured; incidentally also the leading herbaria of the country have been enriched with many valuable specimens, while not a few new species of flowering plants have been brought to light.

The collections made by Mr. HOLWAY show that Mexico has an abundant rust flora, and especially so in the groups represented by the genera Ravenelia and Uropyxis. If collections made during September, October, and November, and over a comparatively small part of that great country have proved so interesting and valuable, more extended search is likely to be rewarded with almost or quite equal results for some time to come.

The following enumeration includes the portion of Mr. HOLWAY's uredineous collections in Mexico, not heretofore published, possessing leguminous hosts, *i. e.*, the rusts occurring upon members of the families Fabaceae, Cassiaceae, and Mimosaceae.

1. UROMYCES TRIFOLII (A. & S.) Lev.—On *Trifolium amabole* HBK., Jalapa, Oct. 3, 1898, no. 3091: *Trifolium* sp., Pachuca, Oct. 27, 1903, no. 5245; City of Mexico, Oct. 28, 1899, no. 3746.

2. UROMYCES MEDICAGINIS-FALCATAE Wint.—On *Medicago denticulata* Willd., Toluca, Sept. 19, 1898, no. 3129.

3. **Uromyces rugosa,** n. sp.—Uredosori hypophyllous, cinnamon-brown; uredospores globoid, 20–24 by 21–27μ; wall light yellow, medium thick, 2–2.5μ, minutely and sparsely verrucose, pores 8, scattered: teleutosori hypophyllous, small, round, 1^{mm} or less across, scattered or somewhat gregarious, soon naked, pulverulent, dull chocolate-brown; teleutospores broadly oval or globoid, 18–22 by 21–27μ, wall dark chestnut-brown, medium thick, 2–3μ, rugose or irregularly and closely verrucose, apex usually bearing a very low, hyaline umbo; pedicel colorless, short, fragile, mostly deciduous. —On *Lupinus* sp., Amecameca, Oct. 21, 1903, no. 5208.

The very rough and opaque spores easily separate this species from all others reported from North America on Lupinus. The uredo stage was not well shown on the specimens studied, and is consequently incompletely described.

4. **Uromyces montanus,** n. sp.—Teleutosori hypophyllous, small, round, crowded in circinating groups, 5–10^{mm} across, centripetal in development, early naked, cinnamon-brown or darker, usually cinereous from germination; teleutospores oval or obovate, pale, 18–24 by 30–40μ, wall very pale brownish, smooth, thin, 1–1.5μ,

thickened at apex, 5–7μ, pedicel colorless, thick, as long as the spore or shorter.—On *Lupinus mexicanus* HBK., Nevada de Toluca, 10,400 ft alt., Oct. 16, 1903.

This collection also showed well-developed aecidia of *Uromyces Lupini* B. & C. upon the same leaves. The teleutospores germinate in the sorus upon maturity.

5. UROMYCES LUPINI B. & C.—On *Lupinus elegans* HBK., Toluca, Sept. 19, 1898, no. 3177: *Lupinus* sp., Pachuca, Oct. 5, 1899, no. 3575; Zapotlan, Oct. 9, 1903, no. 5140; Nevada de Toluca, Oct. 15, 1903, no. 5154; Amecameca, Oct. 21, 1903, no. 5209.

6. **Uromyces Cologaniae,** n. sp.—Uredosori hypophyllous, scattered, round, small, 0.25 mm or less across, soon naked, pulverulent, pale cinnamon-brown, ruptured epidermis barely noticeable; uredospores globoid, 16–23 by 20–27μ, wall pale cinnamon-brown, thin, 1.5–2μ, evenly and minutely echinulate, pores 3–4, equatorial: teleutosori hypophyllous, scattered, round, small, 0.25 mm across, soon naked, pulverulent, cinnamon-brown, ruptured epidermis barely noticeable; teleutospores oval or globoid, 16–20 by 18–26μ, rounded at both ends, wall cinnamon-brown, thin, 1.5–2μ, closely and finely verrucose, apex a little thicker or with a very low, pale umbo, 2–4μ; pedicel colorless, short, fragile; mostly deciduous.—On *Cologania pulchella* HBK., Patzcuaro, Oct. 20, 1898, no. 3192 (type); Toluca, Sept. 20, 1898, no. 3179; Uruapam, Oct. 11, 1899, no. 3615: *C. congesta* Rose, Toluca, Sept. 20, 1898, no. 3179: *C. affinis* Mart. & Gal., Jalapa, Oct. 3, 1898, no. 3193: *Cologania* sp., Oaxaca, Oct. 21, 1899, no. 3703.

The determination of the several hosts was made by Dr. J. N. ROSE of the U. S. National Museum, all with some slight question, as the material was far from complete.

7. UROMYCES APPENDICULATUS (Pers.) Unger.—On *Phaseolus vulgaris* L., City of Mexico, Oct. 15, 1898, no. 3049; Atequiza, State of Jalisco, Oct. 6, 1903, no. 5120: *P. retusus* Benth., near Tula, Sept. 20, 1898, no. 3161: *P. anisotrichus* Scheele, Rio Hondo, near City of Mexico, Sept. 22, 1898, no. 3155: *P. disophyllus* Benth., Chapala, Sept. 18, 1899, no. 3455: *P. coccineus* Jacq., City of Mexico, Oct. 9, 1898, no. 3037; Dos Rios, near City of Mexico, Sept. 22, 1898, no. 3094; Uruapam, Oct. 12, 1899, no. 3625: *P. obvallatus* Scheele, Santa Fé, near City of Mexico, Oct. 18, 1903, no. 5170;

Amecameca, Oct. 20, 1903, no. 5188: *P. atropurpureus* Moc., Iguala, State of Guerrero, Nov. 4, 1903: *Phaseolus* sp., Cuernavaca, Sept. 24, 1898, no. 3021; Cuautla, Oct. 12, 1898, no. 3070, and Oct. 22, 1903, no. 5217; near Tula, Sept. 21, 1898, no. 3187; Etla, State of Oaxaca, Oct. 23, 1899, no. 3729; Guadalajara, Sept. 22, 1903, no. 5021, Iguala; Nov. 4, 1903, no. 5336.

The Mexican collections of this species of rust do not vary in any noticeable way from those made in the United States. *Uromyces obscurus* D. & H. was founded on a Phaseolus rust having what was taken to be a peculiar form of Aecidium, but which proves to be a species of Synchytrium. This name is therefore a synonym of *U. appendiculatus*.

8. UROMYCES FABAE (Pers.) DeB.—On *Faba vulgaris* L., Toluca, Sept. 17, 1898, no. 3189; Patzcuaro, Oct. 13, 1899, no. 3628; and Oaxaca, Oct. 24, 1899, no. 3733.

9. UROMYCES TENUISTIPES D. & H.—On *Meibomia* sp., Dos Rios, near City of Mexico, Sept. 22, 1898, no. 3095; Toluca, Sept. 19, 1898, no. 3097; Cardenas, Oct. 22, 1898, no. 3148; Atequiza, State of Jalisco, Sept. 26, 1899, no. 3503.

The teleutospores are minutely rugose, although they appear smooth when wet. The apex of the spore has a very low, semihyaline umbo, which often disappears, leaving a shallow depression, as mentioned in the original description (BOT. GAZ. **24**:25. 1897).

10. UROMYCES MEXICANUS D. & H.—On *Meibomia* sp., Cuernavaca, Sept. 24, 1898, no. 3019, and Sept. 28, 1898, no. 3124; near Tula, State of Hidalgo, Sept. 21, 1898, no. 3195; Cardenas, State of San Luis Potosi, Oct. 22, 1898, no. 3150; Rio Hondo, near City of Mexico, Sept. 22, 1898, no. 3154; Chapala, Sept. 18, 1899, no. 3447.

11. UROMYCES HEDYSARI-PANICULATI (Schw.) Farl.—On *Meibomia amplifolia* (Hemsl.) Kuntze, Patzcuaro, Oct. 20, 1898, no. 3141: *M. elegans* (Desv.) Kuntze, Rio Hondo, near City of Mexico, Oct. 4, 1899, no. 3569: *M. strobilacea* (Schl.) Kuntze, Guadalajara, Oct. 12, 1903, no. 5146: *Meibomia* sp., City of Mexico, Oct. 14, 1898, no. 3048; Cuernavaca, Sept. 29, 1899, no. 3518 with uredospores only; Morelia, Oct. 14, 1899, no. 3633; Oaxaca, Oct. 18, 1899, nos. 3658, 3659, Oct. 23, 1899, nos. 3716, 3723, Nov. 11, 1903, no. 5385; Santa Fé, near City of Mexico, Oct. 18, 1903, no. 5165; Tlalpam, near City of Mexico, Oct. 19, 1903, no. 5180.

12. **Uromyces Clitoriae,** n. sp.—Uredosori hypophyllous; uredospores globoid, about 23–27μ in diameter, wall thick, 3μ, fuscous, evenly and sparsely echinulate, pores apparently 2: teleutosori hypophyllous, small, round, scattered, dark cinnamon-brown, soon naked; teleutospores ellipsoid, 20–24 by 22–30μ, wall chestnut-brown, evenly thick, 3–3.5μ, minutely and evenly verrucose; pedicel delicate, colorless, less than the length of the spore, caducous.—On *Clitoria mexicana* Link, Jalapa, Oct. 5, 1898, no. 3088.

Only a few uredospores were seen, which were found in parasitized sori. The sculpturing of the teleutospores is minute but very distinctly shown when dry.

13. **Uromyces bauhiniicola,** n. sp.—Spermogonia epiphyllous, gregarious, punctiform, fuscous, subepidermal, seen in section globose, 60–130μ in diameter: teleutosori at first hypophyllous, becoming amphigenous, small, round, about 1^{mm} in diameter, often confluent, early naked, blackish; teleutospores broadly oval or globoid, 15–21 by 20–24μ; wall dark chestnut-brown, semiopaque, thick, 2.5–3.5μ, prominently rugose, thicker and paler at apex, 5–7μ; pedicel colorless, firm, as long as the spore.—On *Bauhinia Pringlei* Wats., Guadalajara, Sept. 28, 1903, no. 5060 (type): *Bauhinia* sp., Iguala, Nov. 4, 1903, no. 5334.

Readily distinguished from the four or five species occurring upon Bauhinia in South America by the very dark, rugose spores, unaccompanied by uredospores. The spores germinate somewhat readily in the sori, not long after maturity.

14. PHRAGMOPYXIS DEGLUBENS (B. & C.) Diet.—On *Brittonamra Edwardsii* (A. Gr.) Kuntze (*Cracca Edwardsii* A. Gray), Cuernavaca, Oct. 30, 1903, no. 5278.

This is the first time the host of this rare and interesting species has been definitely determined. It has only twice been reported before, once in Ecuador on an undetermined species of Coursetia, a genus closely related to Brittonamra. The type collection is recorded on "leaves of some leguminous plant," and is said to come from Texas (Grev. **3**:55), which latter, however, must be an error. The specimen in the cryptogamic herbarium of Harvard University says, "Northern Sonora," and bears the collector's number, the same as recorded by BERKELEY in *Grevillea*. A specimen in the herbarium of the Department of Agriculture at Washington, D. C., says "N. Mexico," but does not bear the collector's number. Both of these specimens are undoubtedly part of the one original collection made by C. Wright. The Washington specimen consists of two leaflets, 5 by 12^{mm},

elliptical, entire, nearly smooth above, slightly hirsute below with scattered hairs, mucronate, short petioluled, texture firm, bearing a few, well-formed, amphigenous teleutosori. The specimen was compared, under the guidance of Dr. J. N. ROSE, with specimens in the phanerogamic herbarium of the U. S. National Museum, but could not be matched.

The collection by Mr. HOLWAY is furthermore noteworthy in possessing aecidia, not heretofore known, which are rather pale and inconspicuous. They may be described as follows: Aecidia hypophyllous, or somewhat amphigenous, crowded in small groups, pale yellow, without peridium, but sparingly encircled by incurved paraphyses; aecidiospores catenulate, globoid or globose-oblong, 13–17 by 15–19μ, wall very pale yellow, thin, 1μ, finely and closely verrucose, paraphyses small, cylindrical, 5–7 by 24–30μ, more or less contorted, wall usually thick, sometimes nearly obliterating the lumen, smooth, colorless: spermogonia epiphyllous, few in groups opposite the aecidia, brownish-yellow, punctiform, inconspicuous, subcuticular, conical, small, 60–80μ broad and half as high, ostiolar filaments 20–24μ long, free.

CALLIOSPORA, nov. gen.—Teleutosori arising from beneath the epidermis, soon naked; teleutospores 2-celled by transverse partition, wall colored, with an external layer which swells in water, germ pores 2 in each cell, lateral. Aecidium and uredo wanting. Spermogonia arising from beneath the cuticle, conical.

15. **Calliospora Holwayi,** n. sp.—Spermogonia epiphyllous, numerous over areas 2–7^{mm} across, punctiform, golden yellow, becoming brown, subcuticular, conical, 80–125μ broad: teleutosori epiphyllous, scattered, sometimes confluent, small, round, blackish-brown; teleutospores elliptical, 26–34 by 40–51μ, rounded at both ends, slightly or not constricted at the septum, inner wall chocolate-brown, thick, 3–4μ, pores two in each cell, outer wall colorless, 2–3μ thick in water, smooth; pedicel colorless, as long as the spore, swelling in water to the diameter of the spore and bursting.—On *Eysenhardtia amorphoides* HBK., Guadalajara, Sept. 28, 1903, no. 5059 (type), Sept. 29, 1903, no. 5068; Oaxaca, Oct. 25, 1899, no. 3737: *E. orthocarpa* Wats., Etla, State of Oaxaca, Nov. 13, 1903, nos. 5404 and 5405.

This species resembles *Uropyxis Eysenhardtiae* (D. & H.) Magn., but differs not only in the absence of the uredo,but in the position of the sori, the measurements of the teleutospores, and their smooth, colorless, outer wall. The collections have been examined by Dr. J. N. ROSE, who says that the species of Eysenhardtia have not been sufficiently studied, and some doubt must attach to the determination of the several numbers.

16. **Calliospora Farlowii,** n. sp.—Spermogonia caulicolous, and sparingly on midrib of leaf, small, punctiform, yellowish-brown, conical, 80–100μ broad, ostiolar filaments 25–40μ long: teleutosori caulicolous, large, confluent, early naked, pulverulent, cinnamon-brown; teleutospores elliptical, 18–24 by 29–42μ, rounded at both ends, slightly or not constricted at the septum, inner wall cinnamon-brown, 2–3μ thick, pores 2 in each cell, outer wall colorless, barely noticeable when swollen in water, minutely verrucose; pedicel colorless, about 6μ thick, short and mostly deciduous.—On *Parosela domingensis* (DC.) Heller (*Dalea domingensis* DC.), Orizaba, Feb., 1888 (*W. G. Farlow*).

I am indebted to the collector for excellent material of this interesting species. In the selection of the specific name I take the opportunity of showing my appreciation of courtesies in sending me material, and also my high regard for the eminent services rendered by Dr. FARLOW to botanical science.

17. **Calliospora Diphysae,** n. sp.—Spermogonia amphigenous, crowded in dendritic groups, or disposed in lines, pale brown, bullate or hemispherical, subcuticular, 100–175μ broad and less than half as high: teleutosori amphigenous and caulicolous, round or elongated, 1–5^{mm} long, early naked, nearly black; teleutospores elliptical, 30–33 by 45–50μ, rounded at both ends, not constricted at septum, inner wall dark chestnut-brown, 3–4μ thick, pores 2 in each cell, outer gelatinous, pale amber-color, 3–4μ thick in water, sparsely and evenly verrucose; pedicel half length of spore or longer, colorless, firm above, at base slightly bulbous and swelling in water to bursting. —On *Diphysa suberosa* Wats., Rio Blanco, near Guadalajara, Sept. 30, 1903, no. 5082.

18. UROPYXIS NISSOLIAE (D. & H.) Magn.—On *Nissolia laxior* Rose, Guadalajara, Sept. 25, 1903, no. 5039: *N. hirsuta* DC., Sayula, State of Jalisco, Oct. 8, 1903, no. 5127; Cuautla, State of Morelos, Oct. 23, 1903, no. 5230: *Nissolia* sp., Cuernavaca, Nov. 1, 1903, no. 5309.

These collections, except the one made in November, show a few uredospores among the teleutospores. The uredospores are globoid or ellipsoid, pale yellow or nearly colorless, 12–16μ in diameter, wall very thin, 0.75μ, finely verrucose, pores very indistinct, few. The paraphyses seen are capitate, thin-walled, and colorless.

19. UROPYXIS DALEAE (D. & H.) Magn.—On *Parosela Dalea* (L.) Britt. (*Dalea alopecuroides* Willd.), Guadalajara, Sept. 26, 1903, no. 5048: *P. mutabilis* (Willd.) Rose, Toluca, Sept. 19, 1898, no. 3188; Amecameca, Oct. 20, 1903, no. 5196, Nov. 20, 1903, no. 5426: *P. acutifolia* (DC.) Rose, Cuautla, State of Morelos, Oct. 23, 1903, no. 5227: *P. Holwayi* Rose, Iguala, State of Guerrero, Nov. 3, 1903, no. 5319: *P. trifoliata* Rose, near Tacubaya, City of Mexico, Oct. 7, 1896, without number; Aguascalientes, Oct. 9, 1903, no. 7705 (*Rose & Painter*).

20. **Uredo Æschynomenis,** n. sp.—Sori mostly hypophyllous, grouped on small reddish spots, or scattered, subepidermal, small, globose, with pseudoperidium formed of imbricated paraphyses by the union of the slender stipes, the free capitate ends lining the inner wall, dehiscent by a central orifice; uredospores stylate, broadly elliptical or globoid, 14–18 by 16–23μ, wall pale yellow, thin, 1μ, very minutely verrucose, pores obscure, about 6, scattered.—On *Æschynomene americana* L., Cuautla, State of Morelos, Oct. 22, 1903, no. 5220.

The spores of this collection are much like those of *Uropyxis Nissoliae*, the hosts of the two species being closely related. But no genus of leguminous rusts known to the writer contains species with a pseudoperidium for the uredo. Until the teleutospores are discovered, it will be impossible to state the affinities of the species.

21. **Ravenelia Lysilomae,** n. sp.—Spermogonia epiphyllous, crowded in small groups, punctiform, rather large, pale brownish-yellow, subcuticular, flattened hemispherical, 80–130μ wide, one-fourth as high: teleutosori epiphyllous on pale spots, becoming amphigenous, small, 0.25–0.5^{mm} across, chestnut-brown, subepidermal, numerous hyphoid paraphyses intermixed with the spores, inconspicuous; teleutospore-heads chestnut-brown, 7–9 cells across, 80–120μ in diameter, smooth, cysts appressed beneath the head, extending from periphery to pedicel, united laterally; pedicel colorless, short, deciduous; paraphyses cylindrical, 7–10 by 30–40μ, light golden-brown, wall thin or rarely thick.—On *Lysiloma tergemina* Benth., Iguala, State of Guerrero, Nov. 3, 1903, no. 5317.

22. RAVENELIA VERRUCOSA Cke. & Ell.—On *Leucaena microphylla* Benth., Iguala, State of Guerrero, Nov. 3, 1903, no. 5314.

This collection differs slightly from the type in having heads almost or quite smooth, and with paraphyses fewer and paler.

23. RAVENELIA LEUCAENAE Long.—On *Leucaena diversifolia* Benth., Etla, State of Oaxaca, Nov. 13, 1903, no. 5408: *L. esculenta* DC., Etla, State of Oaxaca, Nov. 13, 1903, no. 5413; Iguala, State of Guerrero, Nov. 3, 1903, no. 5311: *Leucaena* sp., Guadalajara, Sept. 25, 1903, no. 5044; and Tehuacan, State of Puebla, Nov. 7, 1903, no. 5349.

There appears to be considerable uncertainty in the exact determination of the species of Leucaena. Although these numbers have been submitted to competent authorities, the correctness of the specific names employed here cannot be vouched for.

24. RAVENELIA EXPANSA Diet. & Holw.—On *Acacia filiculoides* (Cav.) Trel. (*A. filicina* Willd.), Iguala, State of Guerrero, Nov. 3, 1903, no. 5312: *A. cochliacantha* Humb. & Bonp., Iguala, State of Guerrero, Nov. 3, 1903, no. 5315; Tehuacan, State of Puebla, Nov. 8, 1903, no. 5353: *Acacia* sp., Yautepec, Oct. 24, 1903, no. 5237.

25. RAVENELIA SILIQUAE Long.—On *Acacia pennatula* Benth., Etla, State of Oaxaca, Nov. 14, 1903, no. 5395.

The type was seen by Mr. LONG only on the fruit, but the present collection, which does not differ in any perceptible way from the type, only shows rust on the leaves. No teleutospores could be found.

26. **Ravenelia gracilis,** n. sp.—Spermogonia amphigenous, punctiform, crowded in groups, prominent, subcuticular, hemispherical, 60–100μ broad and half as high: uredosori epiphyllous, scattered, less than 0.25^{mm} in diameter, nearly round, mamillose, dehiscent by central, irregular rupture, the encircling epidermis forming an aecidioid cup, paraphyses peripheral, or also intermixed with the spores; uredospores elliptical or obovate-oblong, 16–21 by 30–40μ, wall rather thin, 1.5–2.5μ, golden-brown, strongly and evenly echinulate, pores 4–6, equatorial; paraphyses hyphoid, 7–10 by 40–60μ, somewhat contorted, smooth, thin-walled, nearly or quite colorless: teleutosori like uredosori, but without paraphyses; teleutospore-heads chestnut-brown, 5–7 cells across, 75–100μ in diameter, each spore bearing 4–7 slender, nearly colorless tubercles, 3–4μ high; cysts delicate, appressed beneath the head, extending from periphery to pedicel, united laterally; pedicel short, colorless, deciduous.—

On an undetermined species of Mimosaceae, Cardenas, State of San Luis Potosi, Oct. 22, 1898, no. 3144½.

This rust has many characters in common with that on Pithecolobium, although the hosts do not appear to be closely related. The host is a thorny shrub or tree, with evenly twice pinnate leaves; the leaflets oblong, nearly glabrous, entire, about 3 by 7^{mm}. A cupulate gland usually occurs on the main rachis at the insertion of each pair of petioles.

27. **Ravenelia Pithecolobii,** n. sp.—Uredospores in the teleutosori elliptical or broadly oval, 15–18 by 24–30μ, wall golden-yellow, medium thick, 2–3μ, thicker at apex, 3–5μ, evenly verrucose, pores 4–6, equatorial: teleutosori amphigenous, small, round, at first bullate, scattered, subepidermal, chestnut-brown; teleutospore-heads chestnut-brown, 6–8 cells across, 70–90μ in diameter, each spore bearing 2–3 slightly curved tubercles, 5–7μ long, acute, pale brownish; cysts appressed beneath the head, extending from periphery to pedicel, united laterally; pedicel colorless, short, deciduous; paraphyses none.—On *Pithecolobium dulce* (Roxb.) Benth., Guadalajara, Sept. 27, 1903, no. 5051.

28. RAVENELIA MIMOSAE-SENSITIVAE Henn.—On *Mimosa stipitata* Rob., Cuautla, Morelos, Oct. 28, 1903, no. 5228; and Iguala, Nov. 4, 1903, no. 5326: *M. caerulea* Rose, Cuernavaca, Oct. 30, 1903, no. 5290: *M. Galeottii* Benth., Cuernavaca, Oct. 31, 1903, no. 5303: *M. polyanthoides* Rob., Iguala, Nov. 3, 1903, no. 5324: *M. albida* H. & B., Cuernavaca, Sept. 24, 1898, no. 3125, Oct. 29, 1903, no. 5265; and Cuautla, Oct. 20, 1903, no. 5213: *M. alba floribunda* Rob., Oaxaca, Nov. 10, 1903, no. 5368; Etzatlan, State of Jalisco, Oct. 2, 1903, no. 5086: *Mimosa* sp., Etla, State of Oaxaca, Nov. 16, 1903, no. A.

This species appears to be remarkably uniform on all the hosts so far reported for it. *Uredo sensitiva* Speg. (An. Mus. Nac. Buenos Aires **6**:236. 1899) is probably a synonym, judging from the description. All the numbers under this species were submitted to Dr. B. L. ROBINSON of the Gray Herbarium, who determined the hosts.

29. RAVENELIA CASSIAECOLA Atk.—On *Cassia* sp., Oaxaca, Nov. 10, 1903, no. 5359.

This species has not before been reported from Mexico, having been known only from the southeastern United States.

30. **Ravenelia inconspicua,** n. sp.—Uredosori hypophyllous, small, 0.5[mm] or less across, subcuticular, soon naked, pulverulent, ruptured cuticle inconspicuous, paraphyses abundantly intermixed with the spores; uredospores globose or broadly elliptical, 15–20 by 15–22μ, wall medium thick, 2–2.5μ, golden-yellow, closely verrucose, pores about 10, scattered, paraphyses spatulate, smooth, cinnamon-brown, paler below, walls thick, 3–6μ: teleutosori hypophyllous, very small, scattered, blackish, shining, subcuticular; teleutospore-heads chestnut-brown, 6–8 cells across, 60–100μ in diameter, each cell bearing 4–6 cylindrical tubercles, 3μ wide by 5–7μ long, slightly colored; cysts appressed to the under side of the head, 6–10, somewhat united to one another; paraphyses none.—On *Cassia* (or *Caesalpinia*) sp., Zapotlan, State of Jalisco, Oct. 9, 1903, no. 5135.

31. Ravenelia spinulosa Diet. & Holw.—On *Cassia Holwayana* Rose (*C. multiflora* Mart. & Gal.), Cuautla, State of Morelos, Oct. 23, 1903, no. 5226; Oaxaca, Nov. 11, 1903, no. 5390: *C. Galeottiana* Mart., Tehuacan, Nov. 7, 1903, no. 5348: *Cassia* sp., Oaxaca, Nov. 10, 1903, no. 5372; Cuernavaca, Nov. 1, 1903, no. 5310.

32. **Ravenelia pulcherrima,** n. sp.—Uredosori amphigenous, in loose groups or scattered, round, small, 0.25–0.5[mm] across, soon naked, subcuticular, cinnamon-brown, paraphyses numerous, intermixed with the spores; uredospores ellipsoid or oblong-globoid, 15–18 by 17–24μ, wall thin, 1.5–2μ, pale golden yellow, finely and closely echinulate-verrucose, pores 6–8, scattered, paraphyses large, capitate or spatulate, 12–18 by 35–55μ, smooth, walls of the stipe thin and nearly colorless, walls of the head much thickened above, 3–10μ, chestnut-brown: teleutosori amphigenous, small, scattered or confluent, subcuticular, blackish-brown; teleutospore-heads chocolate-brown, 6–7 cells across, 75–120μ in diameter, each spore bearing 4–5 inconspicuous papillae, semihyaline, 1–2μ high; cysts appressed to the underside the head, extending from periphery to pedicel; paraphyses none; pedicel short, colorless, deciduous.—On *Poinciana pulcherrima* L. (*Caesalpinia pulcherrima* Sw.), Yautepec, State of Morelos, Oct. 24, 1903, no. 5236 (type); Iguala, State of Guerrero, Nov. 4, 1903, no. 5337.

33. Ravenelia laevis Diet. & Holw.—Or *Indigofera jaliscensis* Rose, Chapala, Oct. 5, 1903, no. 5108: *I. densiflora* Mart. & Gal.,

Cuernavaca, Sept. 26, 1898, no. 3225, Oct. 30, 1903, no. 5292; Oaxaca, Nov. 11, 1903, no. 5380; Amecameca, Oct. 20, 1903, no. 5203; Santa Fé, near City of Mexico, Oct. 18, 1903, no. 5167: *Indigofera* sp., Etzatlan, State of Jalisco, Oct. 2, 1903, no. 5091.

34. RAVENELIA INDIGOFERAE Tranz.—On *Indigofera cuernavacana* Rose, Cuernavaca, Oct. 30, 1903, no. 5296: *I. Conzattii* Rose, Mt. Alban, State of Oaxaca, Nov. 12, 1903, no. 5392.

35. RAVENELIA BRONGNIARTIAE Diet. & Holw.—On *Brongniartia podalyrioides* HBK., Iguala, State of Guerrero, Nov. 3, 1903, no. 5316.

36. RAVENELIA SIMILIS (Long).—On *Brongniartia podalyrioides* HBK., Guadalajara, Sept. 30, 1903, no. 5181.

37. RAVENELIA TALPA (Long).—On *Cracca Talpa* Rose (*Tephrosia Talpa* Wats.), Guadalajara, Oct. 12, 1903, no. 5151: *C. macrantha* (Wats.) Rose (*Tephrosia macrantha* Wats.), Etzatlan, State of Jalisco, Oct. 2, 1903, no. 5100.

The collection on *C. macrantha* shows some deviation from the type, the tubercles on the teleutospore-heads being larger, and the uredospores being slightly smaller, with germ pores more often scattered.

PURDUE UNIVERSITY,
Lafayette, Ind.

ON THE WATER-CONDUCTING SYSTEMS OF SOME DESERT PLANTS.*

W. A. CANNON.

(WITH TEN FIGURES)

A STATEMENT by VOLKENS[1] to the effect that the ducts of the stems of the shrubs and trees of the Egyptian-Arabian deserts are relatively poorly developed led to an examination of these elements in the shrubs and trees which are growing within reach of the Desert Botanical Laboratory. It appeared at once that our native plants are not poor in water-conducting tissue; on the contrary they are very well provided for in this regard, and I cast about for some means of expressing this condition of affairs from a comparative standpoint. It was especially desired to compare these plants with those of the deserts of Egypt and Arabia, but since the direct comparison was impracticable, because VOLKENS does not give exact data, I have sought a way out of the difficulty by using irrigated desert plants of the species studied as controls. I assume that the desert plants if provided with an abundance of water are for practical purposes mesophytes, and if VOLKENS had in mind the plants of middle Europe, which might well have been the case, we have in this roundabout manner a means of instituting the desired comparison. Aside from this, the great difference in the development of the conductive tissue between desert forms that have been irrigated and those that have not is of considerable interest in itself.

THE PLANTS STUDIED.

This study includes as many of the native desert trees and shrubs as are readily obtained, and also such as have been irrigated in various places in whatever manner or degree. These are the hackberry (*Celtis pallida*), the creosote bush (*Covillea tridentata*), the candle bush or ocotillo (*Fouquieria splendens*), and a relative of the cruci-

*Papers from the Desert Botanical Laboratory of the Carnegie Institution. No. 12.

[1] VOLKENS, G., Flora der ägyptisch-arabischen Wüste, p. 82.

fixion thorn (*Zizyphus lycioides*), representing the shrubs; and the cat claw (*Acacia Greggii*), the mesquite (*Prosopis velutina*), and two species of palo verde (*Parkinsonia microphylla* and *P. Torreyana*), representing the trees.

These plants grow in habitats which are very unlike in appearance, and which presumably are dissimilar also in such fundamentals as soil characteristics and water supply. Speaking now of the vicinity of the Laboratory only, for a radius of about ten miles the habitats may be classed as (1) mesa, (2) river bottoms, (3) the rocky slopes of the lower mountains, and (4) the "draws" of these mountains. As regards the amount of water in the soil available to the plants, the river bottoms should be classed first, after which should be placed the draws; the rocky slopes and the mesa are frequently very dry. The mesa is peculiarly desertic, because a subsoil, the so-called "calliche," which is practically impervious to water, reaches within a few inches of the surface of the ground. The top soil, the adobe, is a clay. In the river bottoms the top soil is several feet in depth.

The mesquite and the cat claw are found especially on the bottom lands, where they may attain the size of forest trees, especially the former. Both of these trees adapt themselves to the drier habitats, however; but in such places they are of much smaller size and are gnarled and much changed in outward appearance. Celtis and Zizyphus also grow on the river bottoms; Fouquieria seems to be confined to the rocky slopes. *Parkinsonia microphylla* also is mostly found on rocky or well-drained slopes, while the other species of palo verde (*P. Torreyana*) is to be found in the draws at a lower level. Finally, the creosote bush, which is the characteristic shrub of the mesa, grows on the bottoms as well as on the mesa, and is there large and most vigorous. The natural distribution of these plants, and also the modification in form which they assume in the various habitats, point to the conclusion that the optimum conditions for them are attained where, other conditions being equal, water is to be had in abundance.[2]

That the greater vigor of the plants on the river bottom, as opposed to those on the mesa, for instance, is not due mainly, if at all, to

[2] Compare "The creosote bush (*Covillea tridentata*) in its relation to water supply," V. M. SPALDING, BOT. GAZETTE **38**: 124. 1904.

differences in the character of the soil, is shown by the manner in which they react to an abundance of water when they are well irrigated, the substratum being otherwise the same. The creosote bush and both species of palo verde thrive equally well by the side of the same irrigating ditch, and the same is true of the other plants mentioned above. That is to say, each of these plants, whatever may be their natural habitat, is most vigorous where the water supply is adequate. The suggestion cannot be avoided, therefore, that the distribution of these plants in this vicinity is in some way indicative of their specific reaction to the minimum rather than to the optimum supply of water. The extent to which this phase of the reaction of desert plants to water may influence their present distribution in this vicinity will be the subject of future experimental investigation at the Laboratory.

As has been suggested above, the irrigated desert plants are the more vigorous in every way. The leaves are larger and are functional for a longer period, and the plants attain also much larger proportions than those that are not irrigated, and they also grow faster. To give but a single instance of the latter, a palo verde well-irrigated four years from the seed is now about eight feet high,while there are many of these trees in the neighborhood of the Laboratory, without doubt many times as old, that are not so high.

With the larger leaf surface of the irrigated plants one would look for a faster rate as well as for a larger total transpiration. Whatever may be the absolute transpiration of the irrigated forms, the structure of the stems of the irrigated as opposed to the non-irrigated plants indicates that the latter have the faster rate. That is, the non-irrigated stems have larger ducts and more of them per equivalent area of cross section than the irrigated stems, which can be taken as indicating the more rapid transpiration of the former.[3]

To anticipate the general conclusions to be drawn from this paper, we may therefore be justified in thinking that the desert plants of this locality, being probably better provided with conductive elements than those of the Egyptian-Arabian deserts, may also have a faster rate of transpiration.

[3] PFEFFER, Physiology of plants 1: p. 216; HABERLANDT, Pflanzenanatomie (3d ed.), p. 288.

THE METHODS AND THE RESULTS.

The number of ducts of the woody cylinder was determined in the following manner and under the following conditions: The branches selected for study were as nearly of the same size as possible, namely 0.6^{cm} in diameter; it did not appear feasible to get them all of the same age. All of the sections were made midway between the nodes. In counting the ducts an arbitrary area as a standard of comparison was taken as follows. A circle 14^{cm} in diameter was drawn on metric paper and octants were struck off. By means of an Abbé camera lucida an image of the section was so thrown on the metric paper that the periphery of the woody cylinder and the two points delimiting any octant coincided. The standard octant had an area of $19.24^{sq\ cm}$ ($14^2 \times 0.7845 \div 8$). Since the magnification employed was 66 diameters, the area actually examined was $0.29^{sq\ cm}$, or $29^{sq\ mm}$.

The method of studying the ducts thus chosen gives the greatest prominence to the latest growth. This was desired for the reasons that the most active transfer of water probably takes place in the more peripheral ducts, and because I could be most sure of the recent history of the plants as regards irrigation.

The term "irrigated" as used in this paper needs a word of explanation. I have been obliged to take whatever plants I might find that had received any water in addition to the rains. In certain instances, to be detailed below, the plants were growing by the side of an irrigating ditch and without question had water in abundance every day of the year. In other cases they were a greater or less distance from the ditch; and in yet other instances the ditch was filled with water for a portion only of the time, say once a month, during the dry season. Some of the forms received little water artificially, as, for example, Zizyphus, which is in the cactus garden at the University of Arizona and is not irrigated oftener than once or twice in a year. When the plants received a small amount of water I have called them "semi-irrigated." The distinction between irrigated and semi-irrigated forms is thus purely arbitrary.

The accompanying table presents a summary of the study. The numbers refer to the number of ducts in $29^{sq\ mm}$ of stem cross section made under the conditions described above.

	Not irrigated	Irrigated	Semi-irrigated
Acacia Greggii	41	..	23
Celtis pallida	51	42	..
Covillea tridentata	80	20	..
Fouquieria splendens	215	..	85
Parkinsonia microphylla	10	164	..
Parkinsonia Torreyana	28	234	..
Prosopis velutina	51	254	..
Zizyphus lycioides	44	..	39

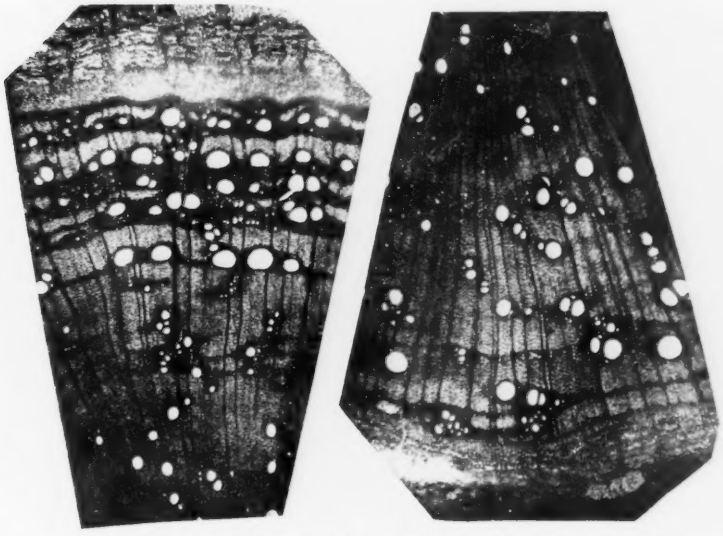

FIG. 1.—*Acacia Greggii*: left, not irrigated; right, irrigated.

The following outline indicates some of the conditions of growth of the plants studied.

ACACIA GREGGII (*fig. 1*).—The non-irrigated specimen was taken by the roadside between an old and at present unused irrigating ditch and the road ditch. Water stands in the latter for a considerable period after each heavy rain, and thus the effects of the rain are considerably prolonged. The irrigated form was growing about 6^{m} from a ditch in which the water flows the most or perhaps all of the year. The older portion of the non-irrigated stem does not

[4] The ducts of the irrigated plants were very small; see *figs. 5, 6, 7*.

have as many ducts as the more recent, an indication according to the present view that this plant might formerly have been irrigated. The owner of the field in which the non-irrigated specimen is found tells me that such, indeed, is the case.

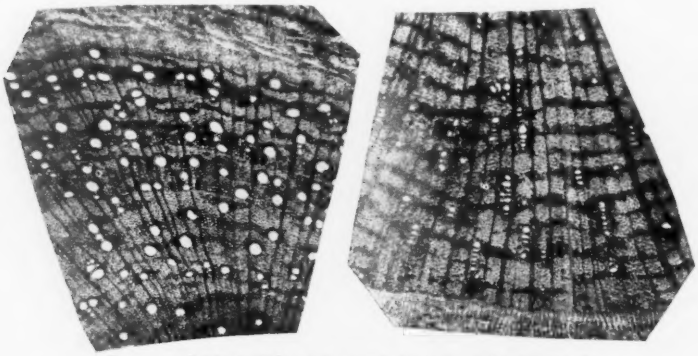

FIG. 2.—*Celtis pallida:* left, not irrigated; right, irrigated.

CELTIS PALLIDA (*fig. 2*).—The non-irrigated plant grows on the mountain on which the Desert Laboratory is situated. The irrigated

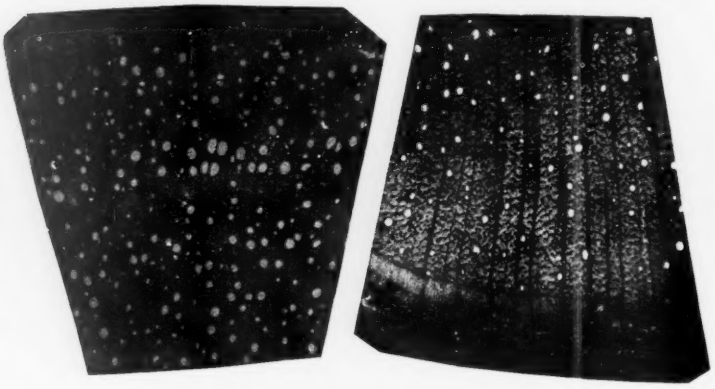

FIG. 3.—*Covillea tridentata:* left, not irrigated; right, irrigated.

plant is on the grounds of the University of Arizona; and has been watered occasionally.

COVILLEA TRIDENTATA (*fig. 3*).—The non-irrigated plant is on the mesa at the northern base of the laboratory mountain. The

irrigated plant is growing by an irrigating ditch. Its roots are without question in a soil which is saturated with water all of the year. A third specimen, not figured, was originally chosen for study as being representative of the irrigated form. It was placed near an irrigating station and was supposed, therefore, to have received considerable water. When I examined the conductive system of this plant I found it to be essentially the same as the non-irrigated specimen. It was learned on inquiry that the plant had not been

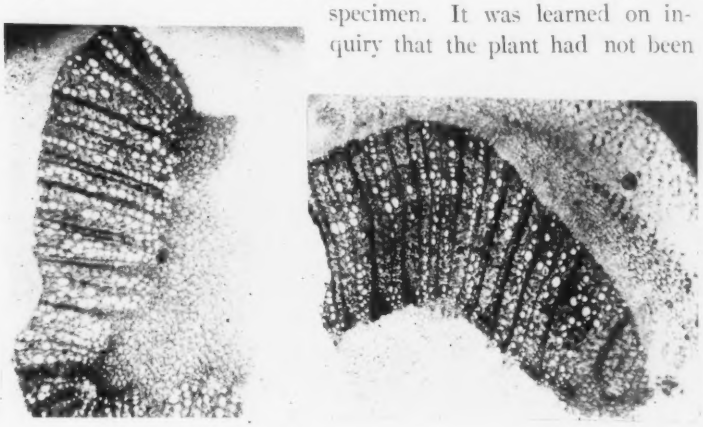

FIG. 4.—*Fouquieria splendens:* left, not irrigated; right, irrigated.

irrigated at all, a curious confirmation of the view advanced in this paper.

FOUQUIERIA SPLENDENS (*fig. 4*).—The non-irrigated specimen is growing on the mountain near the Laboratory. The irrigated is on the grounds of the Indian Industrial School, Tucson. It has received a variable amount of water, more during the past two years than formerly.

PARKINSONIA MICROPHYLLA (*fig. 5*).—The plant that is not irrigated is on the mesa at the northern base of the Laboratory mountain. The irrigated specimen is on the campus of the University of Arizona and has been irrigated frequently.

PARKINSONIA TORREYANA (*fig. 6*).—The non-irrigated palo verde is in the draw at the western base of the Laboratory mountain.

The irrigated plant is on the campus of the University of Arizona and has been irrigated in the same manner as the other species of palo verde given above.

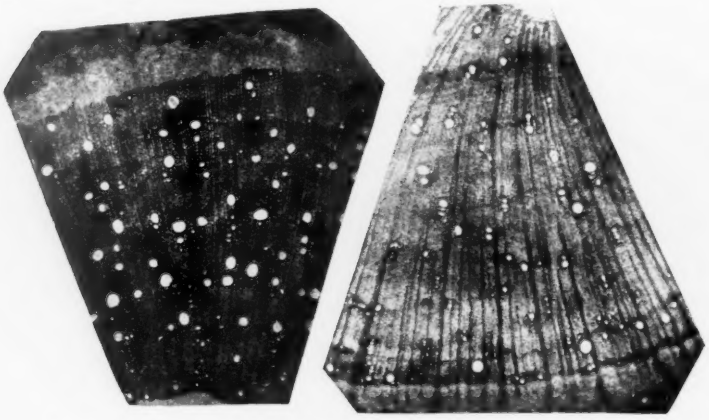

FIG. 5.—*Parkinsonia microphylla:* left, not irrigated; right, irrigated.

PROSOPIS VELUTINA (*fig.* 7).—The non-irrigated specimen of mesquite is growing near the Laboratory. It is about 2^m high,

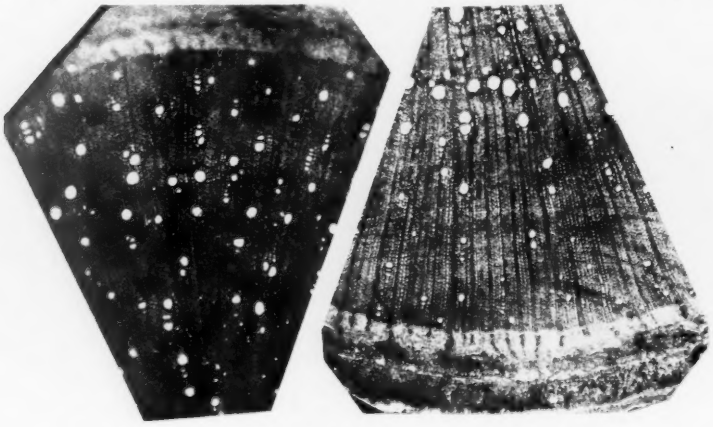

FIG. 6.—*Parkinsonia Torreyana:* left, not irrigated; right, irrigated.

gnarled, and evidently in need of a better supply of water. The irrigated form of mesquite is growing near an irrigating ditch in

which there is water several times during the year; not continuously as in the other ditch mentioned above.

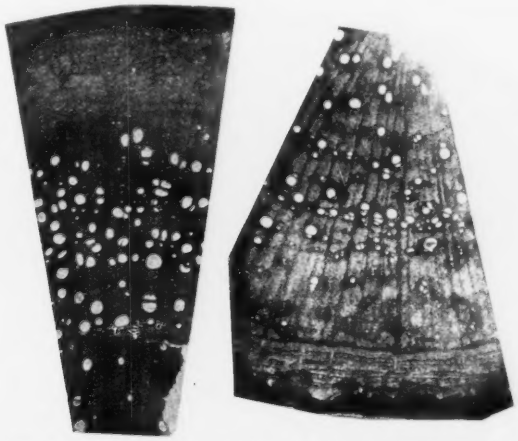

FIG. 7.—*Prosopis velutina:* left, not irrigated; right, irrigated.

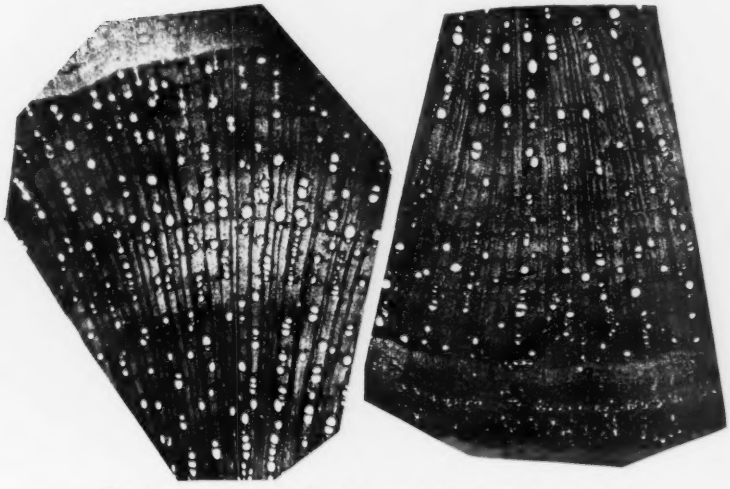

FIG. 8.—*Zizyphus lycioides:* left, not irrigated; right, irrigated.

ZIZYPHUS LYCIOIDES (*fig. 8*).—The non-irrigated plant is on the mesa near Tucson. The irrigated plant is growing on the campus

of the University of Arizona in the cactus plantation. It receives water by direct application about twice a year. The nearest irrigating ditch is across the drive, about 13^m distant. It should be explained that the drive is so constructed with reference to the underlying calliche that presumably no water seeps across.

GENERAL CONCLUSIONS.

Although, much to my regret, the amount of water given to the irrigated plants is not known with any degree of exactness in any case, there can be no mistaking the fact that branches of irrigated plants (even if "semi-irrigated" only) are poorer in conductive tissue than branches of the same diameter of non-irrigated plants. This is an unexpected condition and of especial interest in view of the small development of the water-conducting elements in the non-irrigated forms of the Egyptian-Arabian deserts as given by VOLKENS. It merits further investigation.

Without doubt the irrigated plants have a greater absolute transpiration and organize each year a larger amount of wood than the non-irrigated plants of the same age; but the composition of the wood is different in the two instances. The irrigated plants construct a relatively large amount of non-conductive tissue each year (as compared with the amount of the other wood elements formed), while the reverse is true of the non-irrigated plants. So that it happens, in stems of equal diameter but not of the same age, that the non-irrigated and older stems have more vessels than the irrigated and younger. One other characteristic of non-irrigated stems was also noted, namely, their ducts were usually or frequently of greater diameter.

We find, therefore, a quantitative and a qualitative difference in the structure of irrigated and non-irrigated stems, and from what has been stated it appears that any adequate account of the causes which induce these structural peculiarities must separate the processes which may be associated with the formation of the woody cylinder as a whole from those which may be connected with the organization of that part of the wood that is primarily to conduct water.

I shall not presume at present to offer any hypothesis to explain

the phenomena noted. It seems, however, on the surface of things, that such explanation must take into consideration the differences in the length and the character of the growing season of the two classes of plants. The irrigated plants probably do not cease growing during any month of the year and are most active when the temperature is also the highest. The curve of the growth of these plants probably is very nearly parallel to that of the temperature for the year. The non-irrigated plants are subject to the peculiar climatic conditions of the desert. The summer is the season of the maximum temperature. At Tucson there are each year two rainy seasons: that of winter, January–February; and that of summer, July–August. The period of the greatest vegetative activity occurs at the time of the midsummer rains (it is not known how the winter rains affect the growth of these forms), and all growth ceases very soon after the rains are over. The curve of growth of the non-irrigated plants would be very similar, no doubt, to that for the yearly rainfall. *Fig. 9* expresses in a graphic manner the annual rainfall and temperature at Tucson. It may be taken also to indicate the rate of growth of the non-irrigated and the irrigated desert plants.

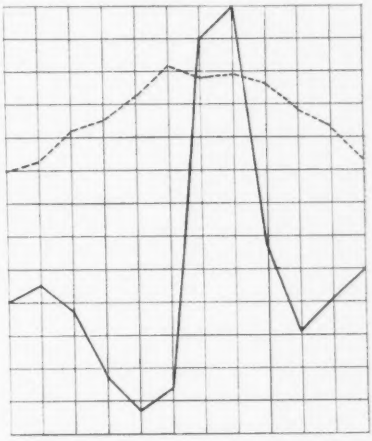

FIG. 9.—Mean yearly rainfall and maximum temperature at Tucson; broken line is temperature ($1^{cm} = 10°F.$); solid line is rainfall in inches ($1^{cm} = 0.2^{in}$).

Whatever may be the effect in detail, it must be admitted, I think, that the growth of the non-irrigated plants, and this may also be true of their transpiration, is directly associated with the distribution of the annual rains. Further, the intensity of this growth, as indicated by the structure of these plants and the general vegetal conditions of the desert, is probably directly connected with the fact that the

heaviest rainfall occurs in summer. These facts encourage the view that the peculiar structure of the plants of the Egyptian-Arabian deserts, as regards the points under consideration, may likewise be due wholly or in part to analogous causes.

The climate of these foreign deserts is quite different from that of the desert about Tucson in the distribution, as well as the amount, of the annual rainfall; and consequently in the relation of the rainfall to the period of the highest temperature. The most rain occurs in the deserts of northwestern Africa and southwestern Asia in winter, but the maximum temperature is in summer.

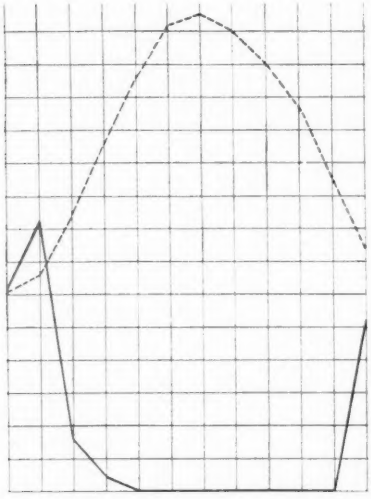

FIG. 10.—Rainfall and temperature at Cairo, Egypt, in 1887; broken line is temperature ($1^{cm}=2°C.$); solid line is rainfall ($1^{cm}=1^{mm}$).

The period of the greatest vegetative activity in these deserts is in winter; in summer the plants are dormant. In the Egyptian-Arabian deserts, therefore, the renewal of growth occurs at the time of the year when the rainfall is also greatest, but not at the season of the highest temperatures. The curve of growth of the plants of this region probably coincides very accurately with the curve of the yearly rainfall. I have no means at hand of telling whether, on the other hand, if such plants were irrigated the period of their greatest growth would fall in summer. Such is apparently the case with some of the cultivated forms[5] in deserts farther west.

Fig. 10 represents the relation of the yearly rainfall to the temperature at Cairo, for the year 1887.

[5] SWINGLE, W. T., The date palm. U. S. Dept. Agric. 1904.

DESERT BOTANICAL LABORATORY.

THE EFFECTS OF TOXIC AGENTS UPON THE ACTION OF BROMELIN.

CONTRIBUTIONS FROM THE HULL BOTANICAL LABORATORY. LXXIII.

JOSEPH STUART CALDWELL.

HISTORICAL.

ATTENTION was first directed to the existence of a proteolytic enzyme in the juice of the pineapple (*Ananas sativus*) by MARCANO (**13**). It was called bromelin by CHITTENDEN, who, with his pupils, examined it in some detail (**3, 4**). They prepared it from the expressed and filtered juice, after neutralization, by saturation with crystals of ammonium or magnesium sulfate or sodium chlorid, any of which precipitate the enzyme together with some proteid matter. The precipitate was dialyzed free from salt in running water, collected upon a filter, and dried at 40° C. upon a water-bath. The flaky, whitish residue thus obtained consisted of the enzyme with some associated proteid. It was soluble in water and active in acid or neutral solutions, very slightly or not at all in an alkaline medium. The sodium chlorid preparation was more active and greater in amount than the others, and was used throughout the experiments. CHITTENDEN'S study was directed principally to a determination of the products of digestion of blood-fibrin, myosin, and coagulated egg albumen. These were found to be hemi- and anti-peptones, proto-, hetero-, and deutero-proteose, leucin, and tyrosin. The enzyme was thus determined to be tryptic in nature, and akin to other vegetable trypsins in that it acted best in an acid medium.

PURPOSE.

The experiments described in this paper were undertaken with a view to ascertaining whether a similarity existed between the effects of poisonous metals upon the action of an enzyme and those observed in experiments upon living organisms. While an immense amount of work has been done with plants and animals, the results are at variance, not even agreeing as to the most poisonous metal.

It was hoped that the limits of toxicity might be more clearly defined in the case of enzymes.

Very little work has been done in this field. In a general way it is known that slight amounts of metallic salts affect enzymic action. COLES (**6**) found that cations and hydroxyl ions depress and anions accelerate the action of ptyalin and invertin. Results with acids and alkalis vary with the enzyme used (**7, 8, 10**). So far as I am able to ascertain, the only extended work with poisonous metals has been that of MCGUIGAN (**16**) upon diastase. His results confirm the theory advanced by MATHEWS (**10, 11**) that the physiological action of any atom or ion depends primarily upon its affinity for its electrical charge. The work described in this paper was undertaken with a view to determining whether this theory would hold for a tryptic enzyme, and was completed before MCGUIGAN'S results were known to me.

Bromelin was chosen as a typical vegetable trypsin, rapid in its action, easily prepared, and hitherto studied only with reference to its digestion-products and its action in the presence of acids and alkalis.

PREPARATION OF THE ENZYME.

It was desirable to prepare the enzyme in as pure a state as possible, since it was early found that the presence of associated proteid matter obscured the results of my experiments. Even very slight amounts apparently shielded the enzyme from the action of poisons. Furthermore, it was shown by some preliminary experiments, summarized elsewhere in this paper, that autodigestion, with the formation of peptones, leucin, and tyrosin, occurred in solutions of the impure enzyme when kept for some time at temperatures between 25 and 65° C.

After several trials, a preparation was obtained which contained only very slight traces of associated proteid, and which was not at all autodigestive. The dialyzed NaCl-precipitate was dissolved in a little water, reprecipitated by the addition of 95 per cent. alcohol, again dissolved in water, and again precipitated by adding crystals of $(NH_4)_2SO_4$. A little of the associated proteid is left behind at every precipitation, and five repetitions of the process gave a preparation containing only slight traces of proteid. Precipitation was much hastened by placing the vessel in the refrigerator at about 4° C.

After being dried upon the water-bath at 40° C., the preparation was wholly soluble in water and was not autodigestive in any medium even after prolonged standing. It was active in faintly acid or alkaline solutions, though not at all in neutral media. This preparation was used throughout the experiments.

In order that the results might not be rendered inaccurate through the use of preparations of unequal purity, all the enzyme used was prepared at one time and thoroughly mixed after drying. From 46 pineapples of average size, 16.4 kg of filtered juice were obtained, which yielded 14.8 gm of the enzyme dried at 40° C. This was kept in a calcium chlorid desiccator and from time to time compared with fresh preparations, but no deterioration occurred in the period covered by the experiments.

The enzyme was most active in solutions of alkalinity equaling *m*/30–*m*/40 NaOH, and was considerably less active in acid solutions irrespective of strength. Its action was wholly inhibited by *m*/10 HNO_3 or H_2SO_4, *m*/15 HCl, NaOH, or KOH, or *m*/20 NH_4OH.

The fact that the enzyme had been found most active in acid and neutral solutions by CHITTENDEN, while my own preparations were markedly more active in alkaline than in acid media and showed only the slightest trace of activity in neutral solutions, led me to a very careful examination of this point. CHITTENDEN'S statement of his method was followed in making a number of preparations. Pineapples of varying ripeness were chosen, upon the hypothesis that a change in the nature of the enzyme might occur with the ripening of the fruit, but all of my preparations agreed perfectly in requiring an alkaline medium for optimum action, very much less action occurring in acid media. One preparation from very immature fruits showed faint activity in a neutral solution. This difference from the results of CHITTENDEN'S examination seems explicable only on the ground that I have misunderstood his statement of his method of preparation; yet the method is simple and the statement is apparently lucid and exact enough to be followed without difficulty.

ISOLATION OF THE ALKALINE ENZYME.

Some of the facts observed in the preparation of the enzyme suggested that it might be in reality a mixture of two enzymes separ-

able by proper treatment. Some experiments with this purpose in view met with partial success.

A neutral solution of one gram of the dry enzyme in 100 cc water was carefully heated to 65° C. Upon gradual addition of NaCl crystals a slight precipitate settled out, which when collected by filtering, and dried, weighed 0.31 gm. The filtered liquid when freed from NaCl showed no activity upon egg-albumen in acid solutions, regardless of strength, but its activity in alkaline solutions was undiminished and accorded in all respects with that of ordinary preparations of the enzyme in alkaline media, the products of digestion with the two being identical. The heat precipitate was imperfectly soluble in water and showed no action upon egg-albumen in any medium.

I believe that these facts, with the differences, elsewhere stated, in the action of poisons upon acid and alkaline solutions of the enzyme, justify the conclusion that there are present in the preparation two enzymes, one active in acid, the other in alkaline solutions. I am aware that full proof of this statement demands isolation of the acid-enzyme without destroying it in the process, but this I am as yet unable to do.

That the presence of NaCl is a necessary condition for the precipitation of the acid-enzyme is shown by the fact that no precipitation occurs in unsalted solutions until heated to 76° C., activity in both acid and alkaline media being retained until complete precipitation occurs at 87–90°.

EXPERIMENTS WITH POISONS.

In the experiments with poisons, solutions containing 0.006 gm of the enzyme per cubic centimeter were made up with distilled water previously made acid or alkaline by the addition of HCl or NaOH. An $m/32$ acid or alkali was adopted as a medium for all digestions, since this strength allowed optimum activity in each case. Thymol was used to prevent bacterial infection and was found perfectly satisfactory. Of this solution 5 cc, containing 0.03 gm of the enzyme, were transferred to each of the test-tubes to be used. To each was then added 5 cc of the poison to be used, of twice the desired strength, *i. e.*, 5 cc enzyme solution plus 5 cc $m/5000$ $Ba(NO_3)_2$ gives

10^{cc} $m/10000$ $Ba(NO_3)_2$. To each tube was then added 1^{gm} egg-albumen previously boiled and granulated, and the tubes were then placed in the water-bath at 40° C. for 24 hours. They were then removed, filtered to remove undissolved albumen, and tested.

Tests were made for peptones, leucin, and tyrosin by all the standard tests. The biuret reaction after precipitation of the albumoses, and the tryptophan reaction described by VINES (**25**, *d*) were

SALT	OPTIMUM ACID MEDIUM *m* 32 HCl		OPTIMUM ALKALINE MEDIUM *m* 32 NaOH	
	Dilution of molecular solution		Dilution of molecular solution	
	Inhibiting	Allowing	Inhibiting	Allowing
$AgNO_3$	110,000	130,000	80,000	100,000
Ag_2SO_4	80,000	110,000	80,000	96,000
$CuSO_4$	60,000	90,000	45,000	60,000
$CuCl_2$	48 000	70,000	40,000	54,000
$HgNO_3$	75,000	90,000	64,000	80,000
$Hg(NO_3)_2$	65,000	85,000	45,000	60,000
$Pb(NO_3)_2$	40,000	60,000	30,000	56,000
$PbCl_2$	37,500	56,000	40,000	56,000
$Zn(NO_3)_2$	28,000	32,000	16,000	22,000
$ZnSO_4$	16,750	23,000	14,000	17,000
$Ba(NO_3)_2$	10,000	13,000	6,000	8,000
$BaCl_2$	8,000	12,000	6,000	7,500
$Cd(NO_3)_2$	6,000	7,600	5,000	7,000
$CdSO_4$	4,800	6,650	4,750	5,650
$Co(NO_3)_2$	4,800	6,400	3,000	4,000
$CoSO_4$	4,500	5,500	3,000	3,600
$LiNO_3$	1,000	1,400	900	1,200
Li_2SO_4	750	1,050	600	900
Na_2SO_4	512	1,024	500	750
$NaNO_3$	1,600	2,000	1,100	1,675
$Sr(NO_3)_2$	900	1,200	720	960
$SrSO_4$	750	1,100	650	1,050
$SrCl_2$	800	1,000	600	900
$Mg(NO_3)_2$	650	1,000	320	512
$MgSO_4$	600	1,000	375	512
KCl	100	160	60	120
KNO_3	100	200	125	175
$(NH_4)_2SO_4$	256	512	256	432
NH_4NO_3	400	512	256	432
NH_4Cl	320	480	275	420

found to be most delicate, HOFFMANN'S and SCHERER'S tests being used as confirmatory. The unequal delicacy of the reactions employed made it necessary to adopt a rule to secure uniformity in results. Hence only such concentrations were considered inhibiting as gave no results with any test, while the only strengths tabulated as allowing

action were those that gave unmistakable results with a majority of the tests. SCHERER'S test—the isolation of leucin and tyrosin—was of course conclusive. The application of this rule resulted in some cases in comparatively wide gaps between the toxic and non-toxic strengths given in the table; *e. g.*, *m*/650 $Mg(NO_3)_2$ is given as inhibiting, since it gave none of the tests; *m*/1000 as allowing action, since it gave all; while *m*/850 gave faint tryptophan reaction but no SCHERER'S test, and was therefore disregarded.

In beginning to experiment with a particular salt, a stock solution was first made; a portion of this was diluted to give the greatest strengths desired, and greater dilutions were made from this by successive additions of distilled water. For example, in my first experiment with $CuSO_4$ a series of tubes with *m*/5000, *m*/10000, up to *m*/400000 were made up in duplicate. The results indicated where the critical points—between *m*/50000 and *m*/100000—were to be expected, the duplicates preventing error. Closer series were then made and repeated until the limits of toxicity and non-toxicity were clearly determined. Finally the whole table was twice checked over in duplicate, so that the figures given represent in every case from eight to twelve concordant results.

The results obtained may be shown by arranging the metals used in the order of toxicity, beginning with the most poisonous. The results obtained by MATHEWS, working with eggs of *Fundulus heteroclitus*, and those of MCGUIGAN with diastase are given for purposes of comparison.

MATHEWS (14)	MCGUIGAN (16)	CALDWELL
Ag	Ag	Ag
Hg	Hg	Hg
Cu	Cu	Cu
Cd	Cd	Pb
Pb	Co	Zn
Zn	Zn	Ba
Co	Pb	Cd
Li	Sr	Co
Sr	Ba	Na
Na	Mg	Li
Ba	Li	Sr
Mg	Na	Mg
NH_4		NH_4
K		K

While there are a number of exceptions, these results show a general agreement which is more striking in view of the total lack of harmony in the earlier work with poisons, whether with plants or animals. Silver, mercury, and copper stand at the head of the three lists. In my experiments, cadmium stands near zinc, nearly in the place it should occupy in accordance with the theory of MATHEWS, who found it in his work only less poisonous than copper. MATHEWS and MCGUIGAN have found sodium less poisonous than lithium or strontium, using the chlorids. I find the three sulfates practically equal in toxicity, while sodium nitrate is much more poisonous than the other nitrates. My results agree more nearly with those of MATHEWS in the places given lithium, lead, and cobalt. The great toxicity of barium in my experiments cannot be attributed to impurities in the salts used or to inaccuracy in performing the experiments, since several standard preparations gave markedly uniform results, and the series has been worked over so many times that the possibility of mistake is excluded.

The nitrates uniformly inhibit the action of the enzyme in somewhat greater dilution than the corresponding sulfates and chlorids, which agree very closely.

The action of the enzyme is markedly weaker and is uniformly inhibited by poisonous solutions of less concentration than when acting in alkaline media. This confirms the evidence already given for the existence of two enzymes.

EXPERIMENTS UPON AUTODIGESTION.

The experiments upon autodigestion were suggested by the discovery that while none of the tests for peptones, leucin, or tyrosin were given by freshly prepared aqueous solutions of the impure enzyme, all these were present in such solutions after standing for a little time at 25–60° C. CHITTENDEN (*loc. cit.*) has stated that the proteids of the juice are exceedingly resistant to the action of the enzymes, while VINES (**25**, *c*) has mentioned the occurrence of autodigestion in the expressed juice. My own observations led to the supposition that the associated proteids were acted upon by the enzyme at suitable temperatures. This was found to be true of acid and alkaline solutions, not of neutral ones. The associated proteid

was first rapidly digested, the breaking down of the enzyme itself proceeding more slowly and continuing until complete.

Solutions containing 1^{gm} each of the impure enzyme were placed in the water-bath and kept at 40° C. for 12 days, the growth of bacteria being prevented by the addition of thymol. At short intervals, portions were removed and examined for digestion products by all the methods employed in other experiments. Traces of peptones, leucin, and tyrosin were found after 1½ hours, rapidly increased in amount for 10–14 hours, then very slowly increased for 9–10 days. During the first day, portions were hourly removed, filtered, and tested as to their activity upon egg-albumen, no perceptible decrease in power being shown. After the first day, portions were removed once or twice daily and tested, and there was found a decrease in power to digest egg-albumen proceeding *pari passu* with the increase of digestion products in the stock solution, until after the eighth day no perceptible action upon egg-albumen occurred, even after prolonged standing. Contrary to my expectation, the process of autodigestion was not checked or inhibited by the accumulation of its products, since it was equally rapid in the stock solution and in another from which the digestion products were daily removed. Furthermore, the two enzymes break down with equal rapidity, since activity in acid and alkaline media decreased equally until the eighth day, after which no action occurred.

No such decrease in activity occurred, nor were digestive products present, in purer preparations of the enzyme kept for a much longer period (five weeks) under similar conditions, nor were such solutions affected by light.

It was hoped that a preparation purer than I had otherwise been able to make might be obtained by allowing the digestion to proceed until the associated proteid had been broken down, separating the products of digestion from the enzyme and drying the latter. To my surprise, digestion immediately began in aqueous solutions made from such a preparation, and would occur perceptibly in the moist precipitate while drying in a calcium chlorid desiccator.

Autodigestion does not begin so long as there are present proteids, either egg-albumen, fibrin, or that present in the juice, but does begin as soon as these have been broken up.

Autodigestion occurs most rapidly in alkaline solutions equaling $m/16$–$m/32$ KOH or NaOH, less rapidly in $m/10$–$m/24$ HCl, H_2SO_4, or HNO_3. Action was inhibited by greater concentrations and occurred more slowly in weaker ones. It occurs with poisons in strengths very much greater than those inhibiting the action of purer preparations upon egg-albumen, as shown by the following table:

AUTODIGESTION IN $m/24$ HCl AT 40° C.

SALT	DILUTION OF MOLECULAR SOLUTION	
	Inhibited	Allowed
$(NH_4)_2SO_4$	72	120
NH_4NO_3	48	64
$Mg(NO_3)_2$	128	256
$MgSO_4$	100	175
$CuSO_4$	6,000	8,650
$AgNO_3$	16,000	22,750
$ZnSO_4$	10,000	16,000
$Sr(NO_3)_2$	600	800
$Cd(NO_3)_2$	512	768
$CoSO_4$	1,600	2,400
$NaSO_4$	150	225

In an alkaline medium ($m/32$ NaOH), inhibiting and allowing strengths were uniformly about one-third greater with the few salts tested.

The table just given also represents pretty closely the conditions for the digestion of egg-albumen by such impure preparations, in so far as this was studied. For example, digestion would just occur in $m/14000$ $ZnSO_4$, $m/7200$ $CuSO_4$, or $m/1800$ $Co(NO_3)_2$, as determined by decrease in the amount of albumen subjected to the test. Hence the degree of susceptibility to poisons is determined largely by the purity of the preparation employed, apparently because the enzyme is shielded by the associated proteid from the action of poisons. The results obtained with preparations of varying purity are parallel, *i. e.*, the toxic strengths of different metals bear approximately the same relation to each other irrespective of the preparation used.

SUMMARY.

1. Impure preparations of bromelin are strongly autodigestive in acid or alkaline media, such digestion beginning when the breaking up of proteid impurities has been completed and proceeding to total destruction of the enzyme.

2. The effects of poisons vary with the purity of the preparation used, slight amounts of proteid impurities rendering necessary an enormous increase of concentration in order to inhibit action.

3. The toxic strengths of the salts used maintain a constant relationship irrespective of the purity of the enzyme used, *i. e.*, silver is always most poisonous, copper third, zinc sixth, and so on.

4. Bromelin, when prepared in a relatively pure condition is not at all autodigestive, the presence of some proteid of the juice apparently being a prerequisite for such action.

5. Such preparations appear to be in reality a mixture of two enzymes, one active in alkaline solutions, slightly more resistant to poisons, and twice as great in amount as the other, which is active in acid media and is destroyed by heating to 65° C. in saline solution.

6. The limits of toxicity and non-toxicity are somewhat more clearly defined than has been the case in experiments upon living organisms (**5, 11, 12, 18, 19, 25**).

7. The results obtained agree in general with MATHEWS's arrangement of the metals upon the theory that "the affinity of the atom or ion for its electrical charge is the main factor determining its physiological action." Cadmium in my experiments occupies the position it should hold in accordance with this theory, while barium is far out of place.*

My sincere thanks are due to Dr. B. E. LIVINGSTON, at whose suggestion the work was begun, for much help in its inception, and to Dr. C. R. BARNES for assistance in its progress and completion.

*Experiments undertaken in order to determine more conclusively the place to be given barium are still in progress. I have found it only relatively less poisonous than zinc in every case, whether bromelin, papäin, or animal trypsin were the enzyme used.

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BRIEFER ARTICLES.

THE EARLY HISTORY OF ANGIOSPERMS.

THE paper lately published by Mr. HAROLD LYON on the embryo of angiosperms[1] gives a clear account of existing views on the race-history of monocotyledons and dicotyledons. In the course of his argument Mr. LYON has referred to my own work on the subject in very generous terms, while giving in greater detail than before the arguments which had already led him to the opposed conclusion. We are, as before, in complete agreement as to the field of battle. We both hold that monocotyledons and dicotyledons come from a common stock, and that the single cotyledon of the one is strictly homologous with both cotyledons of the other. But on the question of the comparative antiquity of these two classes, we start from opposite ends of the lists. I do not propose to discuss the points on which we differ. The evidence on both sides has been published, and also our respective interpretations. Those interested in the question are in a position to form their own judgment on it. The issue will be determined by the results of future research. But Mr. LYON'S lucid statement of the case has shown me that my own is obscure in two points, and I wish to take the first opportunity of restating them.

First I wish definitely to disown the suggestion that the fusion of two ancestral cotyledons might have taken place within the seed where they were acting as sucking organs. This appeared in my first sketch of the whole hypothesis, published in May, 1902.[2] In later papers[3] the fusion of the cotyledons is attributed to the reduction of assimilating organs characteristic of geophilous seedlings in their first season, a second suggestion, inconsistent—as Mr. LYON has pointed out—with the first, which is implicitly abandoned. It would have been clearer to state definitely, as I do here, that—if we consider monocotyledons as derived from a dicotylous stock by adaptation to a geophilous habit—the fusion of two cotyledons

[1] LYON, HAROLD L., The embryo of the angiosperms. American Naturalist **39**: 13–25. 1905.

[2] The origin of the seed-leaf in monocotyledons. New Phytologist **1**: 107–113. *pls.* 2. 1902.

[3] A theory of the origin of monocotyledons. Ann. Botany **17**: 1–92. *pls.* 1–7. 1903. The evolution of monocotyledons. BOT. GAZETTE **37**: 325–345. 1904.

into one is simply and sufficiently explained by the necessity of reduction in the green parts of the seedling, and that this explanation of course requires that the ancestral cotyledons should be acting as green assimilating organs above ground during the period of fusion, and excludes my first suggestion that they fused as sucking organs within the seed.

That my argument was obscure in a more important respect I infer from Mr. LYON'S statement that the evidence on which it is based could as well be read backwards as forwards; in short that the facts on which I rely might be used to prove the derivation of dicotyledons from monocotyledons. My statement of the argument must have been very defective if it admitted of any doubt on this head. No observer dealing with that evidence at first hand could hold such an opinion. He would find the evidence incomplete; he might rate its value much lower than I do; but so far as it goes he must allow that it points in one direction—the derivation of the single from the double cotyledon. To make this clear, the nature of the evidence must be taken into account. It is of three kinds: anatomical, embryological, general.

The anatomical argument is due to Professors QUÉVA and JEFFREY.[4] Both have pointed out that the vascular structure of the young stem in monocotyledons is of the exogenous or dictyledonous type. They both conclude that monocotyledons are derived from dicotyledons. No botanist, I believe, has denied the facts, which I could confirm if necessary. Their theoretical value may be discounted, but the most ingenious critic could hardly use them to prove the descent of dicotyledons from monocotyledons.

The embryological evidence rests primarily on my conclusion that a certain type of vascular structure in the cotyledon and hypocotyl of liliaceous seedlings is primitive, and that various other types of seedling structure in the same family are genetically connected with it. Where we find a single line of related structures there is nothing—in the absence of independent evidence—to show which of the extreme forms is the more primitive. But where—as in this case—there are several distinct lines of descent ending in the same vascular type, it is fair to assume that type as the primitive structure. For a common ancestor naturally gives rise to divergent stocks, but it would be an extraordinary series of coincidences which should lead several distinct types of structure to produce remote descendants of a single type.

It is true that uniform conditions of life do lead to great superficial resemblance between organs which are morphologically distinct. But

[4] QUÉVA, C., Contributions à l'anatomie des Monocotyledonées, p. 147. 1899. JEFFREY, E. C., in COULTER and CHAMBERLAIN'S Morphology of Angiosperms, p. 316. 1903.

the resemblance in such cases is mainly external; the metamorphosis is revealed by differences in internal anatomy. Now in this study of liliaceous seedlings we are dealing with anatomical details which are often uniform, or very nearly so, among allied genera of the most varied external form. Thus, among the Tulipeae some species of Lilium have hypogaeic, other species epigaeic cotyledons; the cotyledon of Fritillaria is of the common green rush-like form; that of Tulipa resembles Fritillaria, but the whole structure of the seedling is transformed by the conversion of the stem bud into a dropper. Yet the same vascular symmetry is found in the cotyledon and hypocotyl of all these divergent forms. On the other hand eedlings belonging to almost every tribe of the family possess the green, rush-like cotyledon, but it masks a great variety of vascular structure. Thus the reappearance of definite vascular symmetry in several lines of descent cannot in this case be put down to the action of external conditions moulding distinct types to one pattern. The one simple and adequate explanation of the facts is that the various lines of descent started from a common ancestor with vascular symmetry of this persistent pattern.

Now the whole argument from this class of evidence depends on the fact that this vascular type is bisymmetrical. Two equivalent and quite distinct bundles traverse the elongated cotyledon; two traces in the hypocotyl unite to form a tetrarch root. A single type which is symmetrical about two planes is connected with several symmetrical about one. There is no difficulty in supposing all these unisymmetrical types to be descended from the one bisymmetrical type; but it is incredible that the descendants of distinct unisymmetrical types should all become bisymmetrical structures of precisely the same kind. The argument may be neglected, but it cannot be read backwards. It cannot be used to demonstrate the formation of two cotyledons from one.

I do not mean to assert that the evidence quoted cannot be reconciled with the hypothesis of a primitive monocotylous angiosperm. The bilateral cotyledon may conceivably represent a terminal member which becomes modified in one fashion or another into the likeness of a lateral one. But this interpretation of the facts explains only how an apparently lateral member may be descended from a terminal one. It is a study in the derivation of various monocotylous types from a primitive monocotylous form; it gives no clue to the descent of a race with two cotyledons from that form.

The same criticism applies to that class of evidence which I have called general. My reasons for considering monocotyledons as a race specialized from a dicotylous ancestor by adaptation to the geophilous habit have

already been given in this journal. They need not be repeated here. On that hypothesis the formation of one cotyledon from two is due to the necessity of reduction in the aerial organs of seedling geophytes. The tendency to such reduction is shown in other ways. Among dicotyledons the few species which have but one cotyledon are geophilous, so—with one exception—are those which have cotyledons united almost to the top. In many geophilous forms the cotyledons never appear above ground at all, and the first leaf is much reduced in size. Adaptation to a geophilous habit also serves to explain many of the other structural features which are correlated in monocotyledons with the presence of a single cotyledon, notably the stem anatomy.

But though the collective weight of evidence in favor of this view appears to me very great, I have never thought it conclusive. There are no facts to make it incredible that the primitive angiosperm was monocotylous, and that modern dicotyledons derive their two cotyledons from division of the original member. That opinion, however, cannot be deduced from the evidence just given. It is conceivable that the geophilous habit has served simply to specialize monocotyledons, operating to reduce the original terminal cotyledon to an apparently lateral one. But that hypothesis does nothing to explain the rise of dicotyledons from a monocotylous race, and it leaves the very marked similarity in vascular structure between the primitive liliaceous type and certain geophilous species of Ranales out of the question. Yet the approach to a true monocotyledonou structure in some of these forms is most striking, and extends to the mature as well as the seedling plant.

In conclusion, I wish again to point out that my purpose in this communication has been to correct an inconsistency in the former statement of my argument, and further to restate a portion of it which has been misapprehended. I have purposely abstained from criticism of Mr. Lyon's alternative hypothesis, and from any attempt to answer his criticisms on mine, except the two which were founded on obscurity in my previous writings.—Ethel Sargant, *Quarry Hill, Reigate, England.*

CURRENT LITERATURE.

BOOK REVIEWS.

A college botany.

PROFESSOR ATKINSON[1] has revised and elaborated his *Elementary Botany* for college use. An elementary college text that includes all of the great divisions of botany seems to be in demand, at least according to the judgment of publishers. Perhaps the demand is both true and just, but it is a large one to make of a single author, who is supposed to be, from the college standpoint, either a morphologist, a physiologist, or an ecologist. One looks for inequality of grasp under such circumstances, unless the presentation is so elementary that it hardly belongs to a modern college course.

In spite of this disadvantage, Professor ATKINSON has covered the whole general field in a way that indicates an unusually wide familiarity with the various divisions of the subject. The parts dealing with physiology and morphology are largely elaborations of the same parts in the elementary text, introducing the new material suited to more advanced students and bringing certain parts up to date. The part dealing with ecology, however, has been entirely reorganized, and represents the first presentation of ecology in an American textbook from the college standpoint.

In the organization of the text, part one (pp. 135) deals with physiology, part two (pp. 207) with morphology, part three (pp. 115) with the ecology of plant members, part four (pp. 184) with plant associations, and part five (pp. 65) with representative families of Angiosperms. The space given to the different parts represents a balance unusually well-maintained for books of this type. There is always a temptation to overdo the part in which the author is especially interested.

Professor ATKINSON believes in numerous and good illustrations, with as many of them original as possible; and hence the volume is full of fresh and suggestive illustrations, and should be of great service to college classes in elementary botany.—J. M. C.

Handbook of plant morphology.

The friends of ARTHUR, BARNES, and COULTER'S *Handbook of Plant Dissection*, published in 1885, will be glad to know that this helpful laboratory guide has been rewritten, thus bringing it again in touch with the best methods of elementary instruction. The authors have delegated the revision to other hands, and both for this reason and on account of changes necessitated by recent developments in botany, it is perhaps fitting that the new edition should appear under

[1] ATKINSON, GEORGE FRANCIS, A college text-book of botany. pp. xvi + 737. *figs.* 592. New York: Henry Holt & Co. 1905. $2.00.

a different title.[1] The most important change noted is the increased number of types discussed, and the presentation of these in a connected account. In harmony with this plan many unrelated details, especially concerning the vegetative structure of the higher plants, are omitted. Though the number of forms discussed is increased from eleven to twenty-five, the size of the book is reduced, having three-fourths the number of pages in *Plant Dissection*. The types selected illustrate very well the probable steps in the evolution of plants, and the discussions are exceedingly clear and suggestive. It seems to the reviewer, however, that the introduction of a heterogamous confervoid form might have strengthened the presentation of the subject of heterogamy among the algae. So long as teachers have too large classes and too little time for purely inductive study in the laboratory, some form of written direction seems indispensable. *Plant Morphology* meets this demand in a most helpful way. A possible danger may lie in its excellence, in that weak teachers may depend upon it too fully and neglect the personal relation which should accompany laboratory study of this character. —R. B. WYLIE.

NOTES FOR STUDENTS.

ALLEN[2] has recently published in full the results of his study of nuclear division in the pollen mother-cells of *Lilium canadense*, following the preliminary announcement which appeared last year.[3] This paper is of especial interest in relation to the final paper of FARMER and MOORE on the reduction divisions in animals and plants, since Allen reaches fundamentally different conclusions as to the events of synapsis and the preparations for the heterotypic mitosis. As FARMER and MOORE also studied a species of Lilium (*L. candidum*), it seems hardly possible that both accounts can be correct, so that the line separating the two schools is sharply drawn in these accounts of a similar form. One school is led by FARMER and MOORE, and finds support in STRASBURGER'S recent paper *Ueber reduktionsteilung* (1904), and in the recent work of GREGORY on the leptosporangiate ferns, and of WILLIAMS on Dictyota. With ALLEN are associated in the chief point of dispute (the formation of the bivalent chromosomes of the heterotypic mitosis) the botanists of the Carnoy Institute, GREGOIRE and BERGHS, and also ROSENBERG.

ALLEN'S account is chiefly remarkable for the detailed study of the events preceding and following synapsis, which are presented in greater detail than in any previous investigation. The nucleus of the young pollen mother-cell contains a network of large irregular masses, derived from the chromosomes of the preceding mitosis in the archesporium, and connected by fibers. As the nucleus increases in size, the chromatin knots become widely separated, and the nucleoli

[1] CALDWELL, O. W., Handbook of Plant Morphology. 12mo. pp. viii + 190. New York: Henry Holt & Co. 1904.

[2] ALLEN, C. E., Nuclear division in the pollen mother-cells of *Lilium canadense*. Annals of Botany **19**: 189–258. *pls. 6–9*. 1905.

[3] BOTANICAL GAZETTE **37**: 464. 1894.

are clearly distinct from the network. During synapsis the reticulum becomes transformed into a definite spirem. the fibers thickening apparently by the distribution of material from the knots, which become less conspicuous. The fibers now arrange themselves in pairs, and a general contraction of the reticulum takes place, probably associated with this approximation of the fibers. There is thus formed a continuous spirem in the nucleus, which is plainly composed of two slender threads lying side by side and probably with no free ends. The two threads often run closely parallel, sometimes loosely twisted about one another, sometimes in contact and apparently fused, and sometimes rather widely separated. It is clear that the double nature of the spirem is not due to a fission, but that two independent threads are developed out of the reticulum. The two threads are regarded as of paternal and maternal origin respectively. They gradually fuse, so that in later stages of synapsis the nucleus appears to contain a relatively thick single (fusion) spirem, which is shorter and more loosely coiled than in earlier stages. Each thread of the pair consists of a series of chromatin granules (chromomeres) imbedded in a ground substance (linin). As the two threads unite, the chromomeres generally come together in pairs and fuse to form a single row of larger chromomeres. The single (fusion) spirem on emerging from synapsis becomes uniformly distributed throughout the nucleus as a much convoluted thread. Some of the loops become fastened to the periphery of the nucleus. There is no regularity in the number of chromatic segments which are formed later.

While evenly distributed the single (fusion) spirem undergoes a longitudinal fusion into two threads, which is preceded by a division of each fusion chromomere. This is the first longitudinal fusion, well known from the descriptions of GREGOIRE, GUIGNARD, MOTTIER, and others. The split spirem now segments into the reduced number of chromatic elements (bivalent chromosomes) characteristic of the heterotypic mitosis. The first free ends of the segments usually appear at the periphery of the nucleus, where it is evident that the split spirem breaks apart at the loops. The segments of the split spirem now shorten and thicken, taking on the various forms peculiar to the heterotypic mitosis. They are obviously pairs of chromosomes, which stand for the full number of sporophytic elements (24), now associated to form a reduced number (12) of bivalent chromosomes. Shortly after the segmentation of the spirem the chromosomes of each pair may show evidence of the second longitudinal fission, which is completed during the metaphase of the heterotypic mitosis. Meanwhile the spindle of the heterotypic mitosis is being organized, the position of the bivalent chromosomes is shifted, and they are arranged on the nuclear plate where the elements of each pair separate as the so-called daughter chromosomes of the heterotypic mitosis. This first division in the spore mother-cell then simply distributes in two sets the twenty-four sporophytic chromosomes which ALLEN believes to have been derived from a maternal and paternal spirem. The second longitudinal fission which becomes conspicuous during metaphase of the heterotypic mitosis is clearly a premature fission of the chromosomes which are to enter the second nuclear

division (homotypic). There is no true resting period between the two mitoses, and the chromosomes which leave the heterotypic figure pass morphologically unchanged into the homotypic.

The chief points of difference between ALLEN's account and that of FARMER and MOORE are briefly as follows: FARMER and MOORE fail to find the organization of two threads preliminary to the formation of the single spirem which emerges from synapsis. They recognize only one longitudinal fusion of this spirem, which is regarded as preliminary to the formation of the chromosomes of the homotypic mitosis. The pairs of chromosomes of the heterotypic mitosis are believed to arise by the approximation of the arms of loops and their separation at the head. The theoretical aspects of these two views in relation to the significance of the reducing division cannot be considered here. The accounts themselves rest on matters of fact and not of interpretation, and one or the other is likely to fall, for it is hardly possible that both can be right, especially since they treat of the same form.

ALLEN presents at the end of his paper a thorough and very interesting discussion of his conclusions in their relation to problems of heredity and hybridization.—B. M. DAVIS.

THE SUBJECT of soil inoculation for legumes has recently acquired a widespread interest in this country, first, from numerous popular accounts relating to the subject, and again on account of a widely advertised commercial product by which is it claimed the proper bacteria can be introduced into the soil. For this reason MOORE's account[4] of his work in this field is of special interest. The first part of the bulletin is a general historical account dealing with the various methods by which nitrogen is fixed in the soil, and leading up to the discoveries of HELRIEGEL and WILLFARTH connecting the fixation of nitrogen by legumes with the tubercles on the roots, and the discovery of bacteria in these tubercles by WORONIN. The chief results of MOORE's investigations may be briefly stated as follows. The root-tubercle organism exists in three well-defined forms. In the soil it has the form of extremely minute motile rods. These possess the power of infecting the root hairs of leguminous plants. Within the root the organisms multiply enormously and produce the hypha-like "infection threads" passing through the tissues of the host. These curious fungus-like structures have often been observed and figured, and have been the objects of much discussion. Their explanation is that they are zooglaea-masses composed of numerous minute bacteria. These minute bacteria soon give rise to larger rod-shaped forms which may or may not be motile. These finally produce the branched forms peculiar to the legume-nodule. It is only this last form that is of any benefit to the plants, for in this state the bacteria are broken down and their contents made available. The name of the organism is changed to *Pseudomonas radicicola*, since the motile rods have flagellae only on one end. There

[4] MOORE, G. T., Soil inoculation for legumes, etc., U. S. Dept. of Agric., Bureau of Plant Industry, Bull. 71, pp. 72. *pls.* 10. 1905.

is only a single species, but several forms or races occur adapted to certain species of legumes. Their slight racial characteristics may be easily broken down by cultivation. The results of studies on the nitrogen-fixing power of the bacteria are extremely interesting, showing that the supposed symbiotic relation between the organism and the root probably does not exist. It is rather to be regarded as a parasite, its nitrogen value being merely incidental to the death of the organism. The nitrogen is fixed by the tubercle-forming bacteria within their bodies. This was determined by cultures in flasks containing nutrient solutions without nitrogen. There was no increase of nitrogen in the solution, but a marked increase in the organisms themselves. In its biology the organism is therefore considered a parasite. Later the plant is able to overcome the parasite and profit by the nitrogen which has been fixed. When grown on nitrogenous media, it was found that the organism lost both its power of infecting leguminous plants and its power of fixing nitrogen. In non-nitrogenous media both of these properties were retained. The failure of NOBBE's attempts in Germany a few years ago to put upon the market pure cultures of this organism can probably be attributed to lack of recognition of this fact. As a result of these studies MOORE has devised a method of putting up for distribution pure cultures of *Pseudomonas radicicola*, grown in nitrogen-free media and dried on cotton immersed in the culture. These cultures are sent out by the U. S. Department of Agriculture together with packages of nutrient salts to multiply the organism. The mass-culture thus obtained is used to inoculate the seed or the soil. Numerous reports from farmers of all states indicate that this method will prove successful and practicable.[5]—H. HASSELBRING.

WÄCHTER[6] has endeavored to solve some of the problems arising from the investigations of PURIEWITSCH on the autodepletion of storage organs. The latter author found inorganic salt solutions to behave as isotonic sugar solutions in accomplishing an inhibition of autodepletion. For this fact PURIEWITSCH accounted by assuming an incipient plasmolysis of the protoplasm, and in cases where inhibition is accomplished by dilute salt solutions he resorted to a fluctuating permeability of the plasma for explanation. WÄCHTER is apparently skeptical of both explanations. For his material the author selected the onion, expecting to avoid such difficulties as are associated with the inversion of insoluble storage products, being able thus to deal only with diosmosing substance, which was supposed to be chiefly glucose in the onion. He finds, however, that glucose is not the chief storage product; that other not directly reducing carbohydrates are present in fully equal amount, and that they exosmose into water or into salt solution in far greater proportion than does the glucose. For this fact the author

[5] By an oversight, only a portion of this review appeared in the BOTANICAL GAZETTE for May, p. 371.—EDS.

[6] WÄCHTER, W., Untersuchungen über den Austritt von Zucker aus den Zellen der Speicherorgane von *Allium Cepa* und *Beta vulgaris*. Jahrb. Wiss. Bot. **41**: 165–220. *fig.* 1. 1905.

remains unable to account. Attempts to correlate with external conditions the relative amounts of reducing and non-reducing sugar exosmosing were unsuccessful. Further experiments indicate that only a partial depletion of such storage organs is possible, while PURIEWITSCH believed complete depletion possible. WÄCHTER believes from his results that the density of the external medium is not a factor in depletion, for he found that even with exosmosis inhibited the density of the cell sap was greater than that of the external fluid. The author remains uncommitted as to the fluctuating permeability of the plasma, and insists that further investigation is necessary to answer this question.—RAYMOND H. POND.

THE X-GENERATION and the 2x-generation is the title of an interesting philosophical paper by LOTSY.[7] The nuclei of the x-generation contains only one-half the number of chromosomes as do the nuclei of the 2x-generation. Only asexually reproducing organisms have the x-number of chromosomes. Then which generation should be called the x-generation? If the fern plant is the x-generation, the prothallium is a ½x-generation; if the prothallium is the x-generation, the fern plant is a 2x-generation. The behavior of the chromatin during fertilization and during the reduction of chromosomes shows that the x-generation is the primitive generation, and that the 2x-generation is later, and that its double number of chromosomes is due to fertilization. Thus the ancient question of the philosophers, which came first, the hen or the egg, can be answered by merely counting the chromosomes. The 2x-generation cannot exist indefinitely, but sooner or later must form reproductive cells in which the primitive number of chromosomes is restored. This reversion to the x-generation consists in the separation of the paternal and maternal chromosomes. The process is preceded by the pairing of these chromosomes, which have remained separated throughout the vegetative life of the organism. Numerical reduction of chromosomes is the expression of this pairing. LOTSY does not hesitate to apply the theory to animals, the body representing the 2x-generation, while the x-generation is reduced to the sexual cells.—C. J. CHAMBERLAIN.

THOMSON[8] has been investigating the megaspore membrane or coat of gymnosperms, naturally applying the term to the investing coat of the prothallium as well as to the coat of the uninucleate spore. This coat is present in all gymnosperms except the Taxeae, among which it is entirely eliminated or nearly so. It consists of two layers, the outer one being suberized, while the inner one is composite in character, being suberized in its outer portion and containing cellulose in its inner portion associated with a substance resembling pectin. In fact, the megaspore coat resembles in structure and composition the microspore coat. The only exception to this general character of the megaspore coat is found among

[7] LOTSY, J. P., Die x-Generation und die 2x-Generation, eine Arbeitshypothese. Biol. Centralbl. **25**:97–117. *4 diagrams.* 1905.

[8] THOMSON, R. B., The megaspore-membrane of the gymnosperms. Univ. of Toronto Biol. Series, No. 4, pp. 64. *pls.* 5. 1905.

the Araucariae, where the suberized outer layer is wanting. In the forms possessing the usual type of membrane, there is present a more or less well-developed tapetum, derived from the sporogenous tissue, which is quite distinct from that derived from nucellar tissue. Using the relative development of the megaspore coat and of the tapetum as a basis, the author concludes that the Abieteae are the most ancient group of Coniferales and the Taxeae the most recent; that the Taxodieae and Podocarpeae are complex, including both ancient and recent forms; and that the Cupresseae occupy an intermediate position in the phylogenetic series.—J. M. C.

NICOLOSI RONCATI[9] has published an account of the ovule of *Anona Cherimolia*. A row of four megaspores and considerable parietal tissue are formed. The innermost megaspore develops a narrow and much elongated embryo sac, whose antipodals appear to be ephemeral. The first divisions of the endosperm cells result in a series of walls across the narrow sac, which is thus divided into a linear series of five or six large chambers. Subsequent divisions fill these chambers with endosperm tissue. The embryo, as figured, has no definite suspensor, but is at first a globular mass of cells. The "rumination of the seed," characteristic of Anonaceae, is attributed by the author to the invasion of the perisperm by infoldings, chiefly from the inner integument. If this be true, it is entirely different from the "rumination" to be observed in Asimina and in Torreya. The name "reserve idioblasts" is given to masses of nutritive material found in abundance in cells along the convolutions of the "rumination," and thought to supply nutrition to the embryo after the endosperm has been digested and the perisperm contains an insufficient nutritive supply. The paper was presented to the Academy by Professor CAVARA.—J. M. C.

JONES[10] has published an account of the anatomy of the stem of Lycopodium. The general conclusions reached are as follows: (1) as the protoxylems increase in number, a series of alternating bands of xylem and phloem is developed; (2) the phloem is scattered through the mass of xylem in more or less isolated patches, until a structure is produced that simulates that of Gleichenia. The first form is developed in creeping stems, the second is characteristic of tropical epiphytes. The young stem has a triarch or tetrarch structure; and the complex structure of larger stems is developed from this by the division of one of the protoxylems into two strands, and by the separation of a phloem into two portions; subsequently, another protoxylem divides, and this process, together with the splitting of the phloem, is repeated until the number of protoxylems and protophloems reaches the number present in the large stem. The disposition of xylem and phloem is constantly altering, the length through which a definite portion of tissue (as a phloem-island) may be traced varying from 0.5 to 8^{mm}.—J. M. C.

[9] RONCATI, F. NICOLOSI, Sviluppo dell' ovulo e del seme nella *Anona Cherimolia* Mill. Atti Acad. Gioenia Sci. Nat. Catania IV. **18**: Mem. 2. pp. 26. *pl.* 1. 1904.

[10] JONES, CHARLES EDWARD, The morphology and anatomy of the stem of the genus Lycopodium. Trans. Linn. Soc. London. II. Bot. **7**: 15–35. *pls.* 3–5. 1905.

ROSE has published a fourth paper under the title "Studies of Mexican and Central American plants."[11] The contribution involves twenty-three families, under which the miscellaneous titles are grouped. Two new genera are described, one (*Ornithocarpa*) in Cruciferae, the other (*Raimannia*) in Onagraceae. The new species described belong to Ostrya (2), Synthlipsis, Thelypodium, Lepidium, Echeveria (2), Ribes (7), Neptunia, Cercidium (3), Parosela (12), Lupinus (16), Indigofera (4), Phaseolus (3), Aeschynomene, Cologania, Crotalaria, Harpalyce, Willardia, Erythroxylon (3), Cedrela, Polygala, Vitis, Heliocarpus (3), Tilia (2), Abutilon (3), Kosteletzkya (2), Robinsonella (2), Ceiba (2), Ayenia (2), Melochia, Taonabo (3), Heterocentron, Conostegia, Monochaetum, Hartmannia (3), Raimannia (3), Eryngium (6), Prionosciadium (5), Arracacia, Coulterophytum, Ligusticum, Museniopsis (2), Oaxacana, Roseanthus, and Schizocarpum. The new genus Raimannia replaces Oenothera as recently understood, twelve species being given as belonging to it; and the name Oenothera replaces Onagra. There is also a synopsis of the Mexican species of Ribes.—J. M. C.

OAKES AMES[12] has begun a sumptuous series of publications dealing with the taxonomy of Orchidaceae. Its purpose is "to illustrate, from type material when possible, new or recently described orchid species, and species heretofore inadequately figured; to publish the original descriptions of all species so figured, with additional characterization, full synonymy, and geographical distribution; to furnish descriptions and descriptive lists of orchidaceous plants, which may prove useful in the study of regional floras; and to communicate the results of critical investigations among special genera." In the first fascicle nineteen species are described and illustrated, five of which are new, the plates being drawn by Blanche Ames and made by the Heliotype Company. There are also the following contents: A descriptive list of orchidaceous plants collected in the Philippine Islands by botanists of the U. S. Government (including sixteen new species); an Oncidium new to the United States; Contributions toward a monograph of the American species of Spiranthes; and A synopsis of the genus Spiranthes north of Mexico.—J. M. C.

KIENITZ-GERLOFF[13] has published a small book dealing with bacteriology. As indicated by the title, it gives a general condensed view of the modern field of bacteriology in its relation to the home, the kitchen, the dairy, etc. A general introduction deals with the evolution of the modern theory of fermentation

[11] ROSE, J. N., Studies of Mexican and Central American plants. Contrib. U. S. Nat. Herb. **8**: 281–339. *pls. 63–72. figs. 14–19.* 1905.

[12] AMES, OAKES, Orchidaceae: illustrations and studies of the family Orchidaceae issuing from the Ames Botanical Laboratory, North Easton, Mass. Fasc. I. pp. vii + 156. *pls. 16.* Boston and New York: Houghton, Mifflin and Company. 1905.

[13] KIENITZ-GERLOFF, FELIX, Bakterien und Hefen insbesondere in ihren Beziehungen zur Haus- und Landwirtschaft zu den Gewerben, sowie zur Gesundheitspflege nach dem gegenwärtigen Stande der Wissenschaft gemeinverständlich dargestellt. 8vo. pp. 100. Berlin: Otto Salle. 1904.

as resulting from PASTEUR'S work on spontaneous generation. An insight is given into the relations of molds, fungi, bacteria, and yeasts to each other, with an outline of their general morphology and classification. Modern methods of cultivation and the introduction of pure cultures in fermentation industries and dairies are discussed. A short chapter is devoted to the activity of bacteria in the soil and their relation to agriculture. Considerable space is finally devoted to pathogens, and the spread of infectious and contagious diseases. Advice and methods are given as to their prevention and treatment. A number of illustrations elucidate the text. The whole book represents a good summary of our present knowledge of micro-organisms in a concise, popular style.—P. HEINEMANN.

GOEBEL[14] has investigated the cleistogamous flowers of a variety of plants from the point of view especially of the adaptation theory, and presents an interesting account of the external condition under which these occur in nature, or can be made to occur in culture. It appears that a large number of plants have the ability to produce cleistogamous instead of chasmogamous flowers under the influence of certain external conditions. Contrary to the belief of DARWIN and others, GOEBEL shows that there is no causal connection between the absence of fertilization, or the formation of seed, and the appearance of cleistogamous flowers. The latter is due to insufficient food relations, and this may arise from poor soil, a lack of mineral constituents, or insufficient light. In many plants the cleistogamous flowers do not set seed. In these cases the appearance of cleistogamous flowers is not due to the suppression of seed-formation, but GOEBEL thinks the seed-formation is suppressed by the appearance of cleistogamous flowers.—W. B. MCCALLUM.

MOLISCH[15] has reported convincing evidence that stems of certain seedlings respond with positive curvatures when exposed to rays emanating from sealed tubes containing a mixture of radium and zincsulfid. The seedlings should be less than 7^{cm} distant from the tubes and preferably about 2^{cm}. Tubes containing radium bromid only (activity 3000) fail to give positive results, as previously found by DIXON. When radium bromid and zincsulfid are mixed, however, a steady phosphorescence of considerable intensity develops, due to the influence of the radium on the zincsulfid. MOLISCH therefore regards the curves obtained as heliotropic, indirectly induced by radium. The interesting fact is also recorded that while such experiments succeed in the laboratory they usually fail in the greenhouse. The author believes that the illuminating gas and other volatile impurities in laboratory air reduce the negative geotropism, thereby increasing sensitiveness to phosphorescence and heliotropic stimulus.—RAYMOND H. POND.

[14] GOEBEL, K., Die kleistogamen Blüten und die Anpassunpstheorie. Biol. Centralbl. **24**:673–697, etc. 1904.

[15] MOLISCH, HANS, Ueber Heliotropismus, indirekt hervorgerufen durch Radium. Ber. Deutsch. Bot. Gesells. **23**:2–7. *fig.* 1. 1905.

THE FIRST CASE of the regeneration of the whole plant from tendrils is described by WINKLER.[16] VÖCHTING first showed that the tendrils of *Vitis vinifera* will produce roots, but on *Passiflora coerulea* WINKLER finds that the isolated tendrils will give rise to both roots and shoots. Young tendrils were cut off and placed in damp sand. They continued to live, but soon became quite woody, and in the course of some weeks formed a callus at the base. After three or four months a root is formed from this callus, and after some months more two shoots arise, also from the callus. The leaves of this plant also form roots and shoots in the same way when similarly treated. The fact is pointed out that the shoots formed from the primary undivided leaves continue to form primary leaves much longer than those formed on the adult leaves. On isolated pieces of stem internodes new shoots arise from the callus at the base.—W. B. MCCALLUM.

POURIEVITCH[17] shows by experiment that the investigations of BONNIER, and MANGIN which have been the basis for the prevailing opinion that the ratio $\frac{CO_2}{O_2}$ does not vary with temperature include some errors, namely comparisons of incomparable material, and tests of too short duration to permit the test objects to acquire the temperature intended for the test. From his own investigations, in which such errors and others are apparently avoided, the author concludes that the ratio $\frac{CO_2}{O_2}$ changes according to temperature, becoming greater as the latter rises. This influence of temperature is most noticeable in young organs, and depends upon the kind of nutritive substance present in the tissues. When this nutritive substance disappears from the tissue, the influence of temperature on the ratio $\frac{CO_2}{O_2}$ becomes less noticeable.—RAYMOND H. POND.

SPALDING showed that when roots are wounded near the tip and traumatropic curvature prevented by placing them in plaster for as long as eight days, they will when removed from the plaster curve in the same way and with the same reaction time as they would have done had they been allowed to do so at first. He considers that the latent period has been prolonged all this time. BURNS[18] has reinvestigated this problem and finds that so long as the wounded tissue persists the stimulus to traumatropic curvature still exists, and unless mechanically prevented the root will curve. When regeneration of the wounded tissue is completed the stimulus is removed. There is thus not a prolongation of the latent period, but a continuation of the stimulus.—W. B. MCCALLUM.

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[16] WINKLER, H., Ueber regenerative Sprossbildung an der Ranken, Blättern und Internodien von *Passiflora coerulea* L. Ber. Deutsch. Bot. Gesells. **23**:45–48. 1905.

[17] POURIEVITCH, M. K., Influence de la température sur la respiration des plantes. Ann. Sci. Nat. Bot. IX. **1**:1–32. 1905.

[18] BURNS, G. P., Regeneration and its relation to traumatropism. Beih. Bot. Centralbl. **28**:159–164. *figs. 4.* 1904.

PRIANISCHNIKOW[19] presents a preliminary report of sand culture experiments which extend his investigations of 1900 on the relative value of different phosphates in plant nutrition. As in the earlier work he found ammonium sulfate to be a "physiologically acid" salt, so now he finds, contrary to all expectations, that ammonium nitrate can also function as a "physiologically acid" salt. This peculiar acidity is much less in the case of ammonium nitrate, however, than in that of ammonium sulfate. The phrase "physiologically acid" is used in the sense suggested by ADOLPH MEYER as applied to a salt whose basic group is more rapidly appropriated by the plant than its acid group.—RAYMOND H. POND.

WORSDELL[20] has discussed the meaning and origin of the phenomenon ordinarily called fasciation, including not merely those abnormal appearances to which the term is ordinarily applied, but also "normal fasciation" as exemplified by such stamen clusters as appear in Hypericaceae and Malvaceae. His contention is that in the development of a structure there are two opposing tendencies, the younger being a tendency to integrity, the latter being a tendency to plurality, and that the condition of the mature structure is the resultant. The mechanical cause suggested has to do with the distribution and functioning of "growth centers."—J. M. C.

PINCHOT[21] has published a second part of his *Primer of Forestry*, dealing with the practice of forestry, work in the woods, and the relation of the forest to weather and streams. There is also a short account of forestry at home and abroad. Numerous reproductions from photographs fill out what is a very satisfactory elementary account of practical forestry. Such literature, prepared by those who have the most ample information, will do more than anything else to educate the intelligent public as to the meaning and need of forestry.—J. M. C.

A GENERAL ACCOUNT of the vegetation of the island of Guam has been published by W. E. SAFFORD.[22] The account includes some reference to every plant known to occur on the island, and discusses the principal plants used for food, fiber, oil, starch, sugar, and forage in the Pacific tropical islands recently acquired by the United States. The method of cultivating and propagating the more important species is treated in considerable detail. While the paper is somewhat miscellaneous as to contents, it is full of information for botanists.—J. M. C.

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[19] PRIANISCHNIKOW, D., Ueber den Einfluss von Ammoniumsalzen auf die Aufnahme von Phosphorsäure bei höheren Pflanzen. Ber. Deutsch. Bot. Gesells. **23**:8–17. 1905.

[20] WORSDELL, W. C., "Fasciation:" its meaning and origin. New Phytologist **4**:55–74. *figs. 17–24.* 1905.

[21] PINCHOT, GIFFORD, A primer of forestry. Part II. Practical forestry. U. S. Department of Agriculture, Bureau of Forestry, Bull. 24. part 2. pp. 88. 1905.

[22] SAFFORD, WILLIAM EDWIN, The useful plants of the island of Guam, with an introductory account of the physical features and natural history of the island, of the character and history of its people, and of their agriculture. Contrib. U. S. Nat. Herb. **9**:1–416. *pls. 1–69.* 1905.

A SMALL MANUAL of poisonous plants has been prepared by A. BERNHARD SMITH.[23] It contains plants from all countries, with their active principles and toxic symptoms, together with the proper treatment in case of poisoning. The main divisions are four in number: (1) plants acting on the brain; (2) those acting on the spinal cord; (3) those acting on the heart; and (4) vegetable irritants. Subdivisions on the basis of symptoms lead one easily to the different groups of plants.—J. M. C.

THE RECENT ADDRESS of Professor D. H. SCOTT as president of the Royal Microscopical Society dealt with the subject of the so-called Carboniferous ferns,[24] which comprise about half of the total known flora. The recent discoveries of seed-bearing forms among them were reviewed, and the conclusion reached that in all probability only a minority of these reputed ferns are really ferns, and that probably the majority of them are seed-bearing plants.—J. M. C.

ARBER[25] has described two new species of the seed-genus Lagenostoma, whose chief interest is its relation to Lyginodendron. An important point in connection with these new species is that the seeds, "with or without a cupular investment," terminate the ultimate branches of what is probably a modified fertile leaf.—J. M. C.

JOHNSTON[26] has published thirty-five new species preliminary to the publication of a flora of the Islands of Margarita and Coche, Venezuela. Among them there is a new genus (*Anguriopsis*) of Cucurbitaceae.—J. M. C.

IN CONTINUING his revision of Eucalyptus, MAIDEN[27] presents *E. amygdalina*, *E. linearis*, and *E. Risdoni*, under each species giving the description, synonymy, range, and affinity.—J. M. C.

SMITH[28] has published an account of three diseases of truck crops in Delaware: (1) a leaf-spot of cucumber, squash, melon, and cantaloupe due to *Sphaerella citrullina;* (2) a leaf-spot of the egg-plant due to *Ascochyta lycopersici;* and (3)

[23] SMITH, A. BERNHARD, Poisonous plants of all countries. pp. xv+88. Bristol: John Wright & Co. 1905.

[24] SCOTT, DUKINFIELD H., What were the Carboniferous ferns? Jour. Roy. Micr. Soc. 1905: 137–140. *pls. 1–3. figs. 32–33.*

[25] ARBER, E. A. NEWELL, On some new species of Lagenostoma: a type of pteridospermous seed from the Coal-measures (abstract). Annals of Botany **19**: 326–328. 1905.

[26] JOHNSTON, J. R., New plants from the islands of Margarita and Coche, Venezuela. Proc. Amer. Acad. **40**: 683–698. 1905.

[27] MAIDEN, J. H., A critical revision of the genus Eucalyptus. Part VI. *pls. 4.* Published by the authority of the Government of the State of New South Wales. 1905. *2s. 6d.*

[28] SMITH, C. O., The study of the diseases of some truck crops in Delaware. Bull. Del. Exp. Sta. 70. pp. 16. *pls. 2. figs. 6.* 1905.

a leaf-spot of the bean and cow pea due to *Phyllosticta phaseolina*. Brief descriptions are given in each case of the fungus itself and its behavior in pure cultures and inoculation experiments. No experiments in the treatment of these diseases are reported. The paper should be of interest to mycologists.—E. MEAD WILCOX.

ROLFS[29] has published his second contribution to the knowledge of a potato disease, called the rosette by SELBY,[30] due to the sterile fungus Rhizoctonia. The author has conducted extensive experiments both in the treatment of the disease and in the study of the life history of the fungus. He finds that the corticium or fruiting stage of the fungus develops freely upon the living stems of the diseased plants, but considers the sclerotial bodies which are common on both stems and tubers the most important agents in the distribution of the fungus. Formalin treatment of the tubers to be planted improved the appearance of the crop but reduced the yield. The corrosive sublimate solution treatment gave good returns when the land employed for the crop was new. Liming the soil and treating the "seed" tubers with sulfur gave negative results. The following recommendations are also made: (1) clean tubers should be carefully selected from healthy tubers for planting, (2) all vines and stems of weeds should be gathered and burned at the end of the season, (3) care must be taken to see that the fertility of the soil is maintained, that through proper methods of cultivation the soil is well aërated, and that where irrigation is employed the water is applied to the land at frequent intervals and in proper amounts, taking care not to allow the soil immediately about the forming tubers to become too wet.—E. MEAD WILCOX.

[29] ROLFS, F. M., Potato failures. A second report. Bull. Col. Exp. Sta. 91. pp. 33. *pls.* 5. 1904. See Bull. 70 Col. Exp. Sta. for the preliminary report upon this subject.

[30] See Bulletins 139 and 145 of the Ohio Experiment Station.

NEWS.

F. C. NEWCOMBE has been advanced to a full professorship of botany at the University of Michigan.

F. E. CLEMENTS, University of Nebraska, has been appointed associate professor of plant physiology.

PROFESSOR F. W. OLIVER, University College, London, has been elected a Fellow of the Royal Society.

JULIUS WIESNER, University of Vienna, has been elected member of the Royal Danish Academy of Science.

N. WILLE, University of Christiania, has been elected foreign member of the Academy of Sciences at Stockholm.

DR. F. DELPINO, professor of Botany in the University and Director of the Botanic Garden, died at Naples May 14.

IDA E. CAROTHERS, University of Chicago, has been appointed instructor in botany at Rockford College, Rockford, Ill.

F. GRACE SMITH, University of Chicago, has been appointed instructor in botany at Smith College, Northampton, Mass.

P. H. OLSSON-SEFFER, Stanford University, is to spend three months in the province of Soconusco, Mexico, in experimental work upon the Mexican rubber tree.

F. D. HEALD, University of Nebraska, has been appointed botanist of the Agricultural Experiment Station and Associate Professor of botany in the University School of Agriculture.

DR. W. B. MCCALLUM, University of Chicago, has received the first Walker prize from the Boston Society of Natural History, the title of his paper being "Physiological analysis of the phenomena of regeneration in plants."

THE BIOLOGICAL STATION of the University of Montana, under the directorship of M. J. Elrod, has announced its seventh annual session at Flathead Lake, Bigfork, Montana, extending from July 12 to August 17. The work in botany will be under the direction of Thomas A. Bonser (University of Chicago) of Spokane.

THE MINNESOTA SEASIDE STATION, under the directorship of Professor Conway MacMillan, has announced its fifth session at Port Renfrew, British Columbia, on the Straits of Juan de Fuca. The session extends from July 8 to August 18, and the botanical staff consists of Conway MacMillan, Albert Schneider, Josephine E. Tilden, and F. K. Butters.

GENERAL INDEX.

The most important classified entries will be found under Contributors, Personals, and Reviews. New names and names of new genera, species, and varieties are printed in **bold-face** type; synonyms in *italics*.

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